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ABSTRACT

Ten replication studies based on quantitative procedures developed to measure motor and sensory/motor skill acquisition among handicapped and nonhandicapped infants and children are presented. Each study follows the original assessment procedures, and emphasizes the stability of interobserver reliability across time, consistency in the response measures, and informal comparisons of performance between handicapped and nonhandicapped infants. The following study topics and authors are included: visual fixation skills (C. Janssen); visual tracking skills (S. Komisar, C. Janssen); visual scanning skills (L. Vogt, C. Janssen); reach (J. Cutsinger, D. Esquith); grasp (C. Mears, D. Esquith); release (S. Courte, D. Esquith); transfer (M. Cisco, D. Esquith); head erect in the prone and supported sitting position in nonhandicapped infants (J. Rues); sitting behavior (C. Thompson, J. Rues); walking behavior (T. Foss, M. Noonan); and standing and sitting (E. Luddy, et al.). (CL)

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QUANTITATIVE ASSESSMENT OF MOTOR AND
SENSORY/MOTOR ACQUISITION IN HANDICAPPED AND
NONHANDICAPPED INFANTS AND YOUNG CHILDREN

VOLUME III

Replication of the Procedures¹

By

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March, 1982

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INTRODUCTION

The present Volume III is a continuation of two earlier documents pertaining to the development of quantitative procedures to measure motor and sensory/motor acquisition among handicapped and nonhandicapped infants and children. Quantitative Assessment of Motor and Sensory/Motor Acquisition in Handicapped and Nonhandicapped Infants and Young Children (Volume I): Assessment Procedures for Selected Developmental Milestones, presented the original procedures of measurement. This volume was distributed as ECI Document No. 255 in April, 1980.

A second document, Quantitative Assessment of Motor and Sensory/Motor Acquisition in Handicapped and Nonhandicapped Infants and Young Children (Volume II): Interobserver Reliability Results for the Procedures, presented the interobserver reliability results separate from the quantitative measurement procedures described in the first volume, and was distributed as ECI Document No. 257 in April, 1981.

The present Volume III presents primarily replication studies for the original procedures described in Volume I. Replication studies in this volume include the motor and sensory/motor areas of visual fixation, tracking, and scanning; the fine motor skills for reach, grasp, release, and transfer; head erect, and walking. Each replication study was conducted over at least a ten week time period, and included both handicapped and nonhandicapped infants and young children. The replication studies followed, with only minor revisions, the original assessment procedures described in Volume I. In each study attention was directed towards the stability of interobserver reliability across time, consistency in the response measures, and informal comparisons of performance between handicapped and nonhandicapped infants.

Two additional studies are included as part of this volume. One presents revised and more efficient procedures for the quantitative measurement of sitting behavior (Thompson and Rues); the second presents original procedures and interobserver reliability results for the quantitative measurement of standing and sitting.

Another study by Rues in this volume was a replication and revision of measures to assess head erect behavior. This study, however, used two sets of normally developing twins as part of the subject population.

The next document to be prepared in this research area (Volume IV) will present the application of the quantitative measurement procedures to measure intervention programs with handicapped children, and to study interactions of sensory/motor acquisition with other related areas of development.

A REPLICATION STUDY:

Quantitative Assessment of Visual Fixation Skills Among
Severely Handicapped and Nonhandicapped Infants and Children¹

by

Cynthia M. Janssen

¹The data reported in this study were collected by Perrin Riggs
May through July, 1980.

Overview of Measurement Procedures

A complete description of the measurement procedures used in this study is found in pages V0 (F) 1 to V0 (F) 13 of Volume I, Assessment Procedures for Selected Developmental Milestones. Procedures were developed to measure the frequency, duration, and mean duration of visual fixations of preferred objects when the child was in a sitting, prone, or side lying position. Visual fixation was considered to occur when the student's eyes were directed toward the stimulus for at least one second. A 3' x 3' plexiglass grid, divided into nine sections, was used to determine placement for presentation of stimulus items: centered directly in front of the child, right of center, left of center, centered up from child, up to the right, up to the left, centered down from child, down to the right, and down to the left. Fixation on objects in each of these grid positions was tested at two distances from the child: grid 6"-12" from child and grid 13"-24" from child. In the original study, it was reported that the distance of the grid did not significantly affect either the child's performance or the reliability, therefore one distance, grid 12"-18" from child, was used in this study.

For each trial the grid was placed directly in front of the child with the examiner directly in front of the child and grid in order to clearly view the child's eyes. A trial began when the stimulus object was presented and the student was instructed to look. The trial ended after 15 seconds had elapsed. The frequency and cumulative duration of visual fixations with the stimulus object was recorded. A mean duration score was then computed by dividing the cumulative duration by the frequency for each grid section. In the original study each student was tested in at least two positions with four observation sessions per position.

Since the procedures were found to be reliable in each of the three positions of the original study, each subject was tested in only one position for this replication. An assessment session was conducted once every one to two weeks for a period of three months. The longitudinal data obtained from this assessment were collected to demonstrate that the procedure was reliable over time, as well as simple and quick to administer.

Subjects

The subjects selected for this study included three handicapped children and one nonhandicapped infant. The handicapped subjects were chosen from a severely/multiply handicapped classroom located in a public school. Selection was based on the criterion of having some visual fixation behavior.

Subject 1. Subject 1 was a severely handicapped 15 year old female with no physical disability. On the TARC she was able to pass 45% of the communication items, 85% of the motor items, and 75% of the self-help items. With correction, her vision was tested as 20/40 for the right eye and 20/30 for the left eye.

Subject 2. Subject 2 was a 16 year old male with a diagnosis of brain damage and heart condition. On the TARC he was able to pass 40% of the communication items, 70% of the motor items, and 40% of the self-help items. He was determined to be untestable on the Parson's Visual Acuity Test.

Subject 3. Subject 3 was a 17 year old female with an AAMD Adaptive Behavior level of IV (severely handicapped). No further test information was available.

Subject 4. Subject 4 was a normally developing male who was observed from 13 to 23 weeks of age.

All of the handicapped subjects were able to sit independently or with positioning aids and were therefore tested in this position. The nonhandicapped infant was propped up on pillows and supported from behind by his mother.

Procedures for Obtaining Measures of Reliability

Reliability was recorded and computed for each trial of every session for both frequency and duration of fixations. Two examiners were positioned directly in front of the child and the grid as close to one another as possible so each could clearly view the child's face from approximately the same angle. Upon completion of a trial each examiner recorded the total number of fixations and the cumulative duration of fixation on the data sheet. Upon completion of a session reliability was determined for each trial and for the total session. Reliability for frequency was computed according to the following formula:

$$\text{Reliability} = \frac{\text{smaller \# of fixations}}{\text{larger \# of fixations}} \times 100$$

Reliability for duration was computed according to the following formula:

$$\text{Reliability} = \frac{\text{shorter duration}}{\text{longer duration}} \times 100$$

Reliability for both frequency and duration of the total session was computed by totaling the frequency and duration reliability scores for each trial and dividing by the total number of trials.

Results

In this section reliability scores and performance data across ten sessions are presented for each of the four subjects. Mean reliability

scores include both frequency and duration of visual fixation by grid section. Performance scores for each subject are represented through graphs of frequency, duration, and mean duration of visual fixation per session.

Reliability Data

Subject 1. Reliability scores for frequency of visual fixation by grid section for Subject 1 are presented in Table 1. The overall mean reliability score across grid sections and sessions was 99%. Reliability scores by grid section within individual sessions ranged from 75% to 100%. Reliability scores for duration of visual fixation by grid section for Subject 1 are presented in Table 2. The overall mean reliability score across grid sections and sessions was 98%. Reliability scores by grid section within individual sessions ranged from 83% to 100%.

Subject 2. Reliability scores for frequency of visual fixation by grid section for Subject 2 are presented in Table 3. The overall mean reliability score across grid sections and sessions was 100%. Reliability scores for duration of visual fixation by grid section for Subject 2 are presented in Table 4. The overall mean reliability score across grid sections and sessions was 98%. Reliability scores by grid section within individual sessions ranged from 91% to 100%.

Subject 3. Reliability scores for frequency of visual fixation by grid section for Subject 3 are presented in Table 5. The overall mean reliability score across grid sections and sessions was 99%. Reliability scores by grid section within individual sessions ranged from 75% to 100%. Reliability scores for duration of visual fixation by grid section for Subject 3 are presented in Table 6. The overall mean reliability

TABLE 1

Mean Reliability Scores for Frequency of Visual Fixation
by Grid Section for Subject 1

Grid Section	Sessions										Total $\bar{X}$ Reliability
	1	2	3	4	5	6	7	8	9	10	
A	100	100	100	100	100	100	100	100	100	100	100
B	100	100	100	100	100	100	100	100	100	100	100
C	100	100	100	100	100	100	100	100	100	100	100
D	100	100	100	100	100	100	100	100	100	100	100
E	100	100	100	100	100	100	100	100	100	100	100
F	100	100	100	100	100	100	100	100	100	100	100
G	100	100	100	100	100	100	100	100	100	100	100
H	75	100	100	100	100	100	100	100	100	100	98
I	100	100	100	100	100	100	100	100	100	100	100
Total $\bar{X}$ Reliability	97	100	100	100	100	100	100	100	100	100	99

TABLE 2

Mean Reliability Scores for Duration of Visual Fixation
by Grid Section for Subject 1

Grid Section	Sessions										Total $\bar{X}$ Reliability
	1	2	3	4	5	6	7	8	9	10	
A	89	99	100	100	99	98	99	99	100	100	98
B	85	92	96	99	98	97	100	97	100	100	96
C	100	100	98	93	96	98	99	97	98	99	98
D	83	94	97	98	98	99	99	99	100	100	97
E	96	90	90	98	99	100	100	99	99	100	97
F	95	93	97	97	100	99	99	99	99	99	98
G	90	100	98	100	100	99	99	98	99	98	98
H	89	96	98	99	98	99	99	96	98	99	97
I	99	99	97	97	99	98	98	98	100	100	99
Total $\bar{X}$ Reliability	92	96	97	98	99	99	99	98	99	99	98

TABLE 3

Mean Reliability Scores for Frequency of Visual Fixation
by Grid Section for Subject 2

Grid Section	Sessions										Total X Reliability
	1	2	3	4	5	6	7	8	9	10	
A	100	100	100	100	100	100	100	100	100	100	100
B	100	100	100	100	100	100	100	100	100	100	100
C	100	100	100	100	100	100	100	100	100	100	100
D	100	100	100	100	100	100	100	100	100	100	100
E	100	100	100	100	100	100	100	100	100	100	100
F	100	100	100	100	100	100	100	100	100	100	100
G	100	100	100	100	100	100	100	100	100	100	100
H	100	100	100	100	100	100	100	100	100	100	100
I	100	100	100	100	100	100	100	100	100	100	100
Total X Reliability	100	100	100	100	100	100	100	100	100	100	100

TABLE 4

Mean Reliability Scores for Duration of Visual Fixation
by Grid Section for Subject 2

Grid Section	Sessions										Total $\bar{X}$ Reliability
	1	2	3	4	5	6	7	8	9	10	
A	96	98	96	99	100	99	99	99	100	100	98
B	97	100	99	99	99	99	99	100	99	100	99
C	89	86	97	96	99	100	100	99	100	100	97
D	98	96	99	99	99	100	100	99	100	99	99
E	91	95	96	100	100	100	100	100	100	100	98
F	95	97	99	98	98	99	99	99	99	100	98
G	91	100	99	99	97	98	98	100	100	100	98
H	94	97	99	100	100	99	99	100	99	99	99
I	96	98	98	99	99	100	100	100	99	100	99
Total $\bar{X}$ Reliability	94	96	98	99	99	99	99	99	99	99	98

TABLE 5

Mean Reliability Scores for Frequency of Visual Fixation
by Grid Section for Subject 3

Grid Section	Sessions										Total $\bar{X}$ Reliability
	1	2	3	4	5	6	7	8	9	10	
A	100	100	100	100	100	100	100	75	100	100	98
B	100	100	100	100	100	100	100	100	100	100	100
C	100	100	100	100	100	100	100	100	100	100	100
D	100	100	100	100	100	100	100	100	100	100	100
E	100	100	100	100	100	100	100	100	100	100	100
F	100	100	100	100	100	100	100	100	100	100	100
G	100	100	100	100	100	100	100	100	100	100	100
H	100	100	100	100	100	75	100	100	100	100	98
I	100	100	100	100	100	100	100	100	100	100	100
Total $\bar{X}$ Reliability	100	100	100	100	100	97	100	97	100	100	99

TABLE 6

Mean Reliability Scores for Duration of Visual Fixation
by Grid Section for Subject 3

Grid Section	Sessions										Total $\bar{X}$ Reliability
	1	2	3	4	5	6	7	8	9	10	
A	98	95	98	100	99	98	100	98	100	99	99
B	99	100	89	99	98	98	100	99	100	100	98
C	82	96	100	100	97	100	99	98	100	100	97
D	99	99	99	99	100	97	98	97	100	99	98
E	97	100	98	98	99	100	99	99	100	97	99
F	95	95	100	100	100	99	93	100	97	93	97
G	94	92	100	100	97	98	100	100	100	100	98
H	94	100	97	97	99	99	99	99	99	100	99
I	100	92	99	99	99	98	100	100	100	100	99
Total $\bar{X}$ Reliability	95	97	97	99	99	99	99	99	99	99	98

score across grid sections and sessions was 98%. Reliability scores by grid section within individual sessions ranged from 82% to 100%.

Subject 4. Reliability scores for frequency of visual fixation by grid section for Subject 4 (nonhandicapped infant) are presented in Table 7. The overall mean reliability score across grid sections and sessions was 98%. Reliability scores by grid section within individual sessions ranged from 75% to 100%. Reliability scores for duration of visual fixation by grid section for Subject 4 are presented in Table 8. The overall mean reliability score across grid sections and sessions was 98%. Reliability scores by grid section within individual sessions ranged from 73% to 100%.

All Subjects. Reliability scores for frequency of visual fixation by grid section across subjects are presented in Table 9. The overall reliability score was 99%. Mean reliability scores by grid section across subjects ranged from 95% to 100%. Reliability scores for duration of visual fixation by grid section across subjects and presented in Table 10. The overall reliability score was 98%. Mean reliability scores by grid section across subjects ranged from 95% to 99%.

Performance Data

Subject 1. The frequency, total duration, and average duration of fixation across all grid sections for each session are displayed in Figure 1 for Subject 1. Session frequency scores ranged from 1.50 to 2.28 fixations with a mean of 1.74 visual fixations. Total duration scores per session ranged from 5.01 to 9.98 seconds with a mean of 7.69 seconds. Mean duration scores ranged from 2.86 to 7.06 seconds per session with a mean of 4.92 seconds.

TABLE 7

Mean Reliability Scores for Frequency of Visual Fixation
by Grid Section for Subject 4

Grid Section	Sessions										Total $\bar{X}$ Reliability
	1	2	3	4	5	6	7	8	9	10	
A	100		100	100	100	100	100	100	100	100	100
B	75		100	100	100	100	100	100	100	100	97
C	100		100	100	100	100	100	100	100	75	97
D	100	no data	100	100	100	100	100	100	100	100	100
E	100		100	100	100	100	100	100	100	100	100
F	100		100	100	100	100	100	100	100	100	100
G	100		100	100	100	100	100	100	100	100	100
H	75		84	100	100	100	100	100	100	100	95
I	100		100	100	75	100	100	100	100	100	97
Total $\bar{X}$ Reliability	97		98	100	97	100	100	100	100	97	98

TABLE 8

Mean Reliability Scores for Duration of Visual Fixation
by Grid Section for Subject 4

Grid Section	Sessions										Total $\bar{X}$ Reliability
	1	2	3	4	5	6	7	8	9	10	
A	99		99	100	99	100	100	99	100	100	99
B	73		98	100	89	100	99	98	100	100	95
C	94		97	98	98	99	100	99	100	99	98
D	96	no data	99	99	99	99	99	99	100	100	99
E	99		98	91	99	98	99	96	100	100	98
F	96		96	99	95	99	99	100	100	100	98
G	93		99	99	99	100	99	96	99	98	98
H	75		92	100	99	99	99	99	100	100	96
I	100		99	99	99	98	99	99	99	100	99
Total $\bar{X}$ Reliability	92		97	98	97	99	99	98	99	99	98

TABLE 9

Mean Reliability Scores for Frequency of Visual Fixation
by Subject and Grid Section

Grid Section	Subject				Total $\bar{X}$ Reliability
	1	2	3	4	
A	100	100	98	100	99
B	100	100	100	97	99
C	100	100	100	97	99
D	100	100	100	100	100
E	100	100	100	100	100
F	100	100	100	100	100
G	100	98	100	100	99
H	98	100	98	95	98
I	100	100	100	97	99
Total $\bar{X}$ Reliability	99	99	99	98	99

TABLE 10

Mean Reliability Scores for Duration of Visual Fixation
by Subject and Grid Section

Grid Section	Subject				Total $\bar{X}$ Reliability
	1	2	3	4	
A	98	99	99	99	99
B	96	99	98	95	97
C	98	97	97	98	98
D	97	99	98	99	98
E	97	98	99	98	98
F	98	98	97	98	98
G	98	98	98	98	98
H	97	99	99	96	98
I	99	99	99	99	99
Total $\bar{X}$ Reliability	98	98	98	98	98

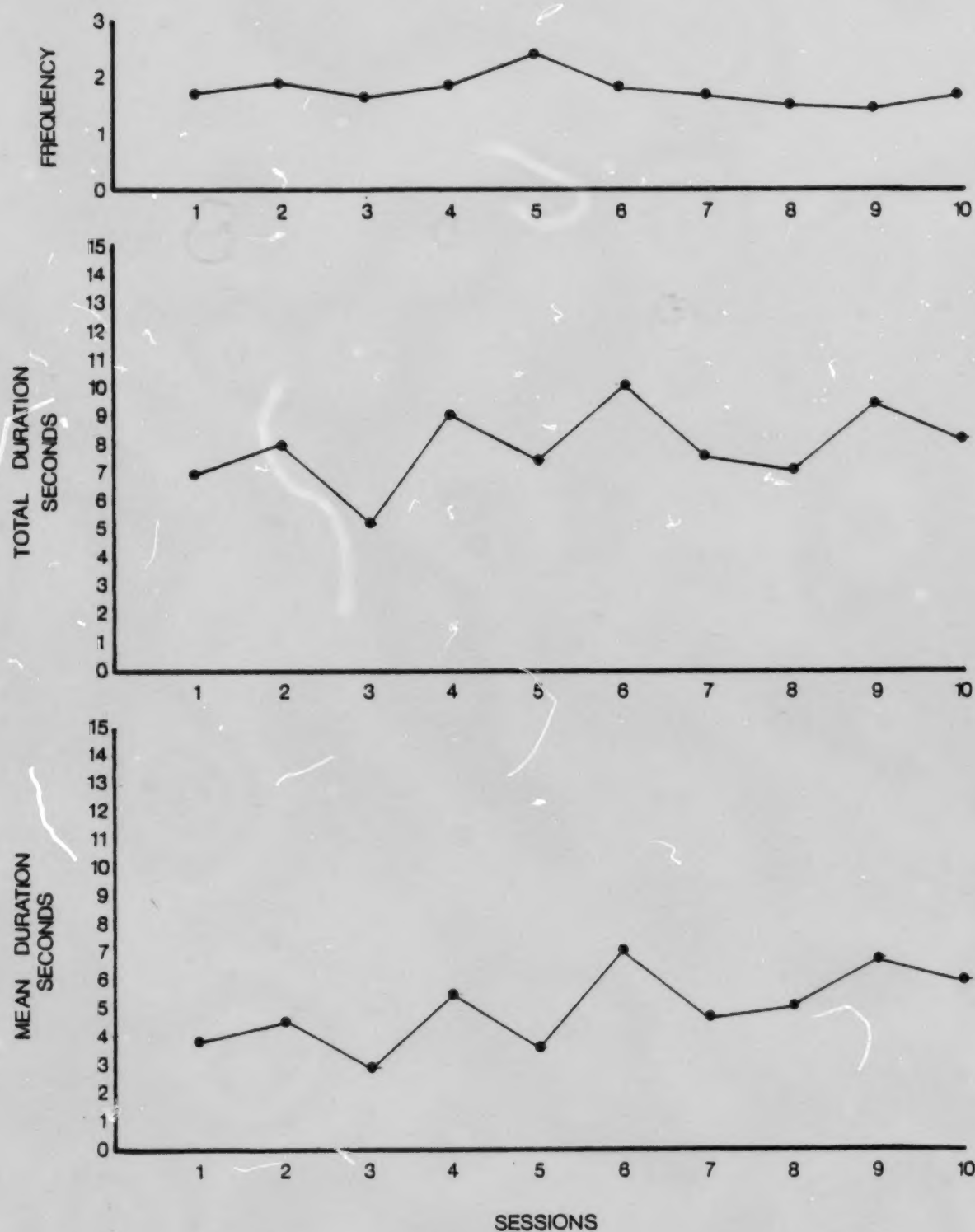


Figure 1 : Frequency and Duration of Visual Fixations for Subject 1

Subject 2. The frequency, total duration, and average duration of fixation across all grid sections for each session are displayed in Figure 2 for Subject 2. Session frequency scores ranged from 1.61 to 2.67 fixations with a mean of 2.14 visual contacts. Total duration scores per session ranged from 8.43 to 11.33 seconds with a mean of 9.65 seconds. Mean duration scores ranged from 3.35 to 7.83 seconds per session with a mean of 5.37 seconds.

Subject 3. The frequency, total duration, and average duration of fixation across all grid sections for each session are displayed in Figure 3 for Subject 3. Session frequency scores ranged from .72 to 1.22 visual contacts with a mean of 1.04 fixations. Total duration scores per session ranged from 2.36 to 6.71 seconds with a mean of 4.77 seconds. Mean duration scores ranged from 2.17 to 5.95 seconds per session with a mean of 4.09 seconds.

Subject 4. The frequency, total duration, and average duration of fixation across all grid sections for each session are displayed in Figure 4 for Subject 4. Session frequency scores ranged from 1.44 to 2.89 contacts with a mean of 2.10 visual fixations. Total duration scores per session ranged from 4.99 to 13.37 seconds with a mean of 9.65 seconds. Mean duration scores ranged from 3.75 to 8.73 seconds per session with a mean of 5.64 seconds.

Discussion

The interobserver data collected on the three handicapped children and one nonhandicapped infant tested in the sitting position indicated that this measurement procedure provided a tool that was clearly reliable for measuring frequency and duration of visual fixations. The overall reliability score across subjects and grid sections for fre-

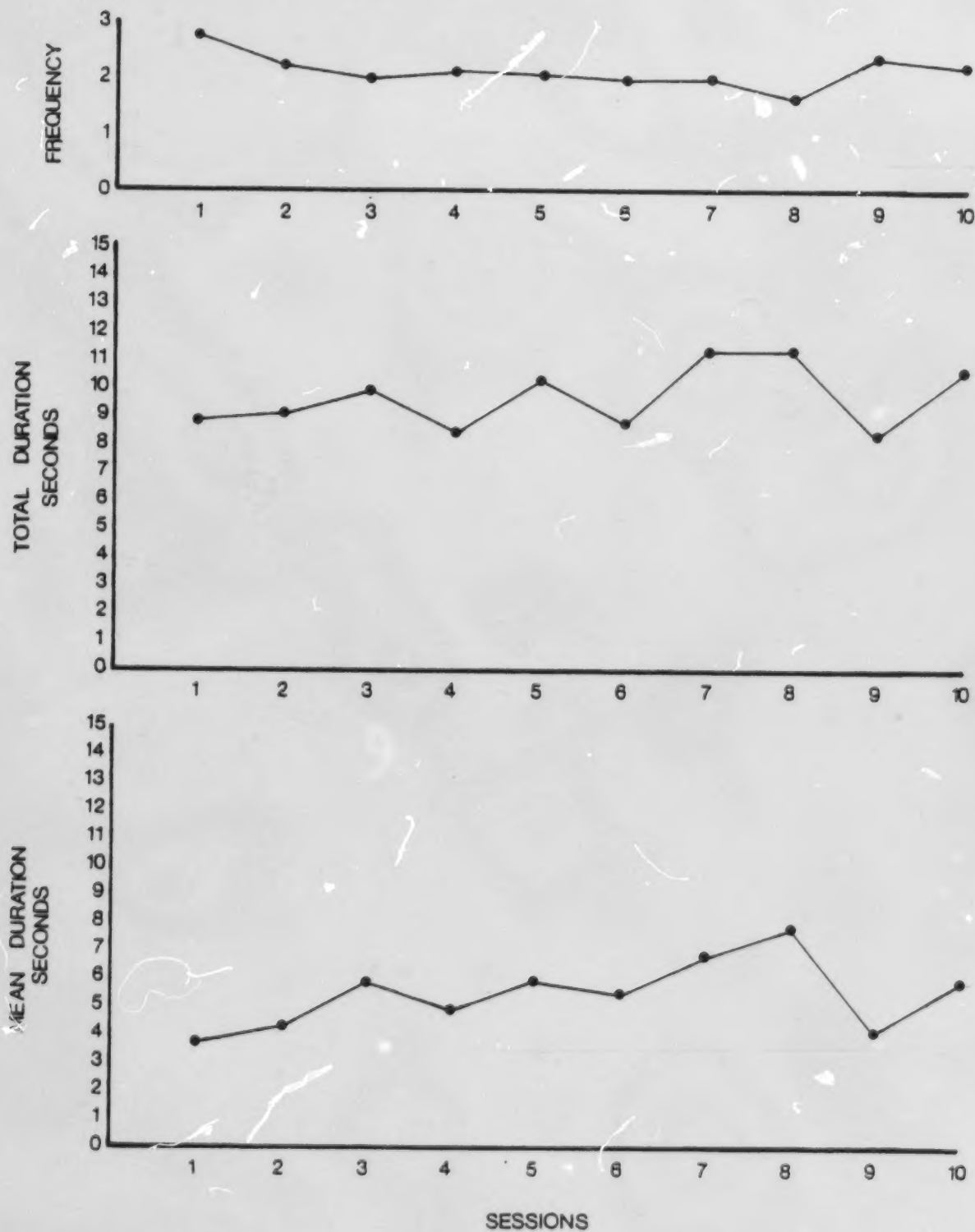


Figure 2: Frequency and Duration of Visual Fixations for Subject 2

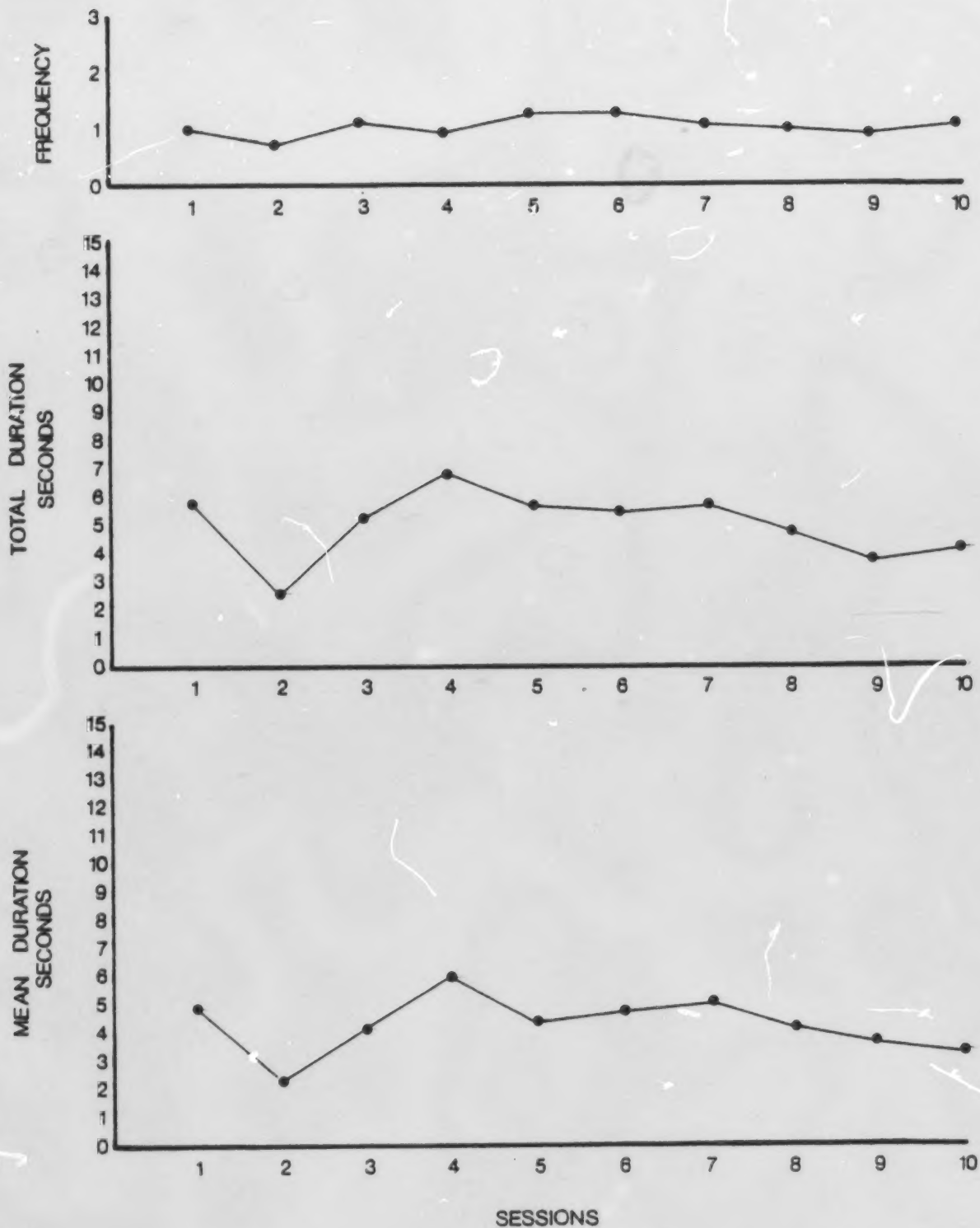


Figure 3: Frequency and Duration of Visual Fixations for Subject 3

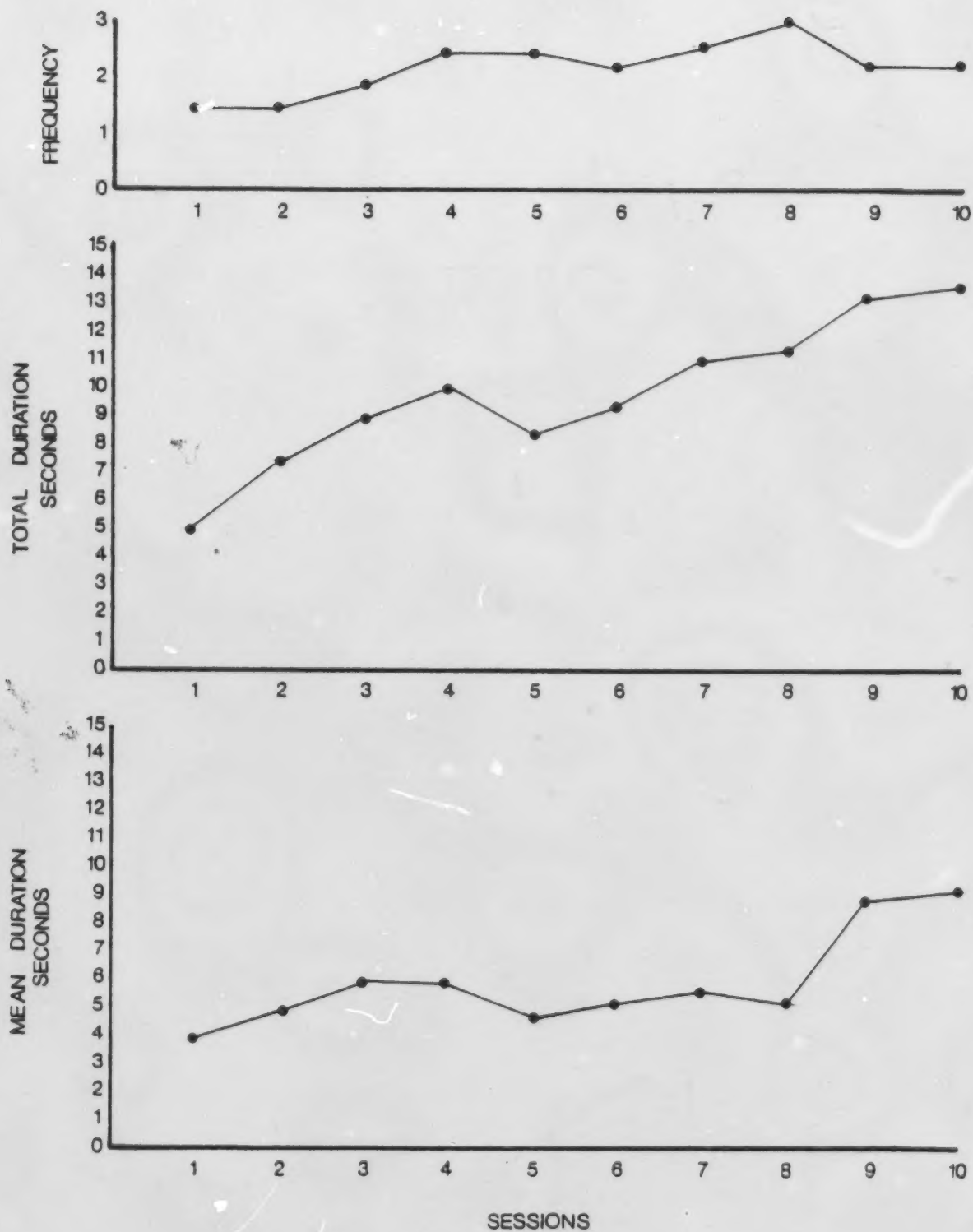


Figure 4: Frequency and Duration of Visual Fixations for Subject 4

quency of visual fixations was 99%, and 98% for duration of visual fixations. These scores were higher than the mean reliability scores of 97% for frequency and 91% for duration of visual fixations reported in the original study conducted under similar conditions. Although all subjects for this study were tested in a sitting position, the original study demonstrated that these procedures were also reliable with subjects tested in prone and sidelying positions, thus allowing for various physical limitations of individual students.

The performance scores for Subject 4 (nonhandicapped infant) suggest that these measurement procedures are effective in measuring small increments of change as visual fixation skills emerge. However, further studies of nonhandicapped infants are necessary to verify this finding.

The performance scores for the handicapped subjects indicate that 10 weeks was not a long enough period of time to observe growth. The scores from one week to the next reflect considerable variability. Perhaps additional trials per grid section within each session or additional sessions are necessary to gain more consistent scores for handicapped subjects.

These procedures were found to be quite efficient. Session length was reduced by combining the two distances originally used into one (12"-18") since the grid did not have to be moved between trials. The scoring system was found to be easy to understand and simple to use as evidenced by the minimum of instructions necessary to train observers. Finally, the plexiglass grid apparatus was fairly inexpensive, easy to assemble, and could be easily stored in a classroom.

The implications of this assessment procedure for practical application in an SMH classroom are several. Performance results could be

used to pinpoint weaknesses in individual students, therefore, providing training objectives for those deficient skills. Periodic assessment could be used to measure training progress, therefore alleviating the need for daily data recording of fixation. The results could also be used to determine preferences for placement of stimuli for other programs such as those in the preacademic and prevocational curriculum domains.

Further study is necessary, however, in the use of the procedures developed to assess visual fixation. This should include determining how to integrate these procedures into a more comprehensive total assessment package. There should also be further investigation of the use of these procedures with nonhandicapped infants over several months as visual skills are developing in order to observe if patterns of emerging visual behaviors are detected. Further research should also concentrate on the use of the visual fixation assessment as a tool for measuring progress as a result of intervention efforts with handicapped students.

In summary, the procedures to measure visual fixation originally described in Volume I and modified slightly in this study were found to be highly reliable, were effective in detecting developmental change in one nonhandicapped infant, and were time and energy efficient to use. The assessment procedures have implications for both practical application and for future research efforts.

A REPLICATION STUDY:
Quantitative Assessment of Visual Tracking Skills Among
Severely Handicapped and Nonhandicapped Infants and Children¹

by
Shelley A. Komisar
and
Cynthia M. Janssen

¹ The procedures and data reported in this study were taken from a Master's thesis by Shelley A. Komisar that was submitted to the Department of Special Education, University of Kansas, in 1981.

Overview of Measurement Procedures

A complete description of the measurement procedures used in this study is found in pages VO(T) 1 to VO(T) 15 of Volume I, Assessment Procedures for Selected Developmental Milestones. Procedures were developed to measure the distance the eyes followed a preferred object when the child was in a sitting, prone, or sidelying position. Tracking behavior first involved fixation on a stationary object, followed by movement of the eyes which corresponded in topography to movement of the stimulus object. A 3' x 3' plexiglass grid, divided into nine sections was used to determine movement paths of stimulus objects to be tracked: horizontal left to right, horizontal right to left, vertical up to down, vertical down to up, diagonal upper left to lower right, diagonal lower right to upper left, diagonal upper right to lower left, diagonal lower left to upper right, circular clockwise, and circular counterclockwise. Tracking of objects in each of these paths was tested at two distances from the child: grid 6"-12" from child and grid 18"-24" from child. In the original study, it was reported that the distance of the grid did not significantly affect either the child's performance or the reliability, therefore one distance, grid 12"-18" from child, was used in this study.

For each trial the grid was placed directly in front of the child with the examiner directly in front of the child and grid in order to clearly view the child's eyes. A trial began when the stimulus was presented and the student was instructed to look. If fixation occurred within 5 seconds of this command the object was moved in the designated path. A trial ended when movement of the stimulus through the path was complete. The number of sections in the tracking path in which tracking occurred was recorded for each trial. In the original study each student was tested

in at least two positions with four observation sessions per position. Since the procedures were found to be reliable in each of the three positions in the original study, each student was tested in only one position for this replication. An assessment session was conducted once every one to two weeks for a period of three months. The longitudinal data obtained from this assessment were collected to demonstrate that the procedure was reliable over time, as well as simple and quick to administer.

Subjects

The subjects selected for this study consisted of three handicapped children and a nonhandicapped infant. The handicapped subjects were chosen from a severely/multiply handicapped classroom located in a public school. They were chosen for this study because they demonstrated that they had acquired the skill of visual fixation, were tracking with some consistency, but were not yet visually scanning. The nonhandicapped infant was selected because she demonstrated the acquisition of visual fixation, but was not yet tracking.

Subject 1. B.S. was a 7½ year old severely retarded and nonambulatory female. Her primary physical disability was chronic hypotonia.

Subject 2. K.C. was a 6½ year old ambulatory female with a 13Q chromosomal disorder. She was severely retarded.

Subject 3. R.O. was a 10½ year old severely retarded and nonambulatory male. He was diagnosed as having Cornelia DeLange Syndrome.

Subject 4. E.B. was a 2 month old nonhandicapped female infant at the onset of testing.

All of the handicapped subjects were able to sit independently and were therefore tested in this position. However, to prevent inappropriate

and interfering movements of the child, they were all tested while sitting in an adult's lap. The nonhandicapped infant was propped up on pillows and supported from behind by her mother.

Procedures for Obtaining Measures of Reliability

Reliability measures were taken for each trial of every session by paraprofessionals in the classroom and by graduate students. A second examiner (observer) was positioned in close enough proximity to have a full view of the subject's eye movements. Both examiners faced the student who was positioned on the other side of the grid. Instructions primarily consisted of explaining the data sheet in detail along with pointing out the section labels to accurately identify sections which the student tracked with a plus (+), and sections not tracked with a minus (-). Also, as each stimulus was presented it was checked off in the appropriate column for each trial. The entire session was completed before a comparison was made of the tracking responses observed by each person who scored.

The degree of reliability was determined by using the following formula:

$$\frac{\text{\# of agreements}}{\text{\# of agreements} + \text{\# of disagreements}}$$

For each trial, the total number of agreement was established by comparing the data for each examiner under the sections-tracked columns. The number of agreements was added to the number of disagreements to represent the total number possible. The percent of reliability was derived by dividing the number of agreements by the number of agreements plus the number of disagreements and multiplying by 100.

Results

In this section reliability scores are presented which indicate the mean percent of agreements, over ten observations, between the examiner and the reliability observer. Mean reliability scores for each tracking plane are presented, as well as mean reliability scores for each session. Reliability scores for four planes were determined by dividing the ten pathways into their respective planes and averaging the mean scores. Performance scores for each subject are represented as the percent of sections tracked across each tracking plane over ten sessions.

Reliability Data

Subject 1. Table 1 lists the reliability scores obtained for Subject 1 by pathways, planes, and sessions. The total mean reliability score for all pathways was 98%. The greatest percent of reliability was 100%, found in the diagonal plane; the lowest level of 95% was found in the circular paths. The reliability scores for testing sessions ranged from 96-100%, with an average of 98%.

Subject 2. The reliability scores for Subject 2 are shown in Table 2. The total mean reliability score for the four planes was 99%. The horizontal planes had the highest reliability of 100%, and the circular pathways averaged the lowest percent of reliability with a score of 97%. The mean reliability for sessions was 98%.

Subject 3. As shown in Table 3, the total mean reliability score for all four planes was 98%. Both vertical and horizontal planes had the highest reliability scores of 99% and circular paths had the lowest score of 97%. The mean reliability for sessions was 98%.

Subject 4. Table 4 lists the reliability scores obtained for Subject 4. A mean score of 99% was reached for all tracking planes. Vertical planes

TABLE 1

Reliability by Tracking
Pathway for Subject 1

Paths	Sessions										Total $\bar{X}$ Reliability	
	1	2	3	4	5	6	7	8	9	10	by path	by plane
→	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99% horizontal
↑	100%	100%	100%	100%	100%	67%	100%	100%	100%	100%	97%	
↗	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
↘	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100% diagonal
↖	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
↙	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
→	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97% vertical
↓	100%	100%	100%	100%	100%	100%	100%	100%	67%	100%	97%	
↻	88%	100%	100%	88%	100%	100%	100%	75%	88%	100%	94%	
↻	100%	100%	100%	88%	88%	100%	100%	100%	100%	88%	95%	95% circular
Total $\bar{X}$ Reliability	99%	100%	100%	98%	99%	96%	100%	98%	96%	96%	98%	98%

TABLE 2

Reliability by Tracking
Pathway for Subject 2

Paths	Sessions										Total $\bar{X}$ Reliability	
	1	2	3	4	5	6	7	8	9	10	by path	by plane
→	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100% horizontal
↑	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
↗	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
↖	100%	100%	67%	100%	100%	100%	100%	100%	100%	100%	97%	99% diagonal
↘	100%	100%	100%	100%	100%	100%	67%	100%	100%	100%	97%	
↙	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
→	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99% vertical
↓	100%	100%	100%	100%	100%	67%	100%	100%	100%	100%	97%	
↻	100%	88%	100%	100%	88%	88%	100%	100%	88%	100%	95%	
G	100%	88%	100%	100%	100%	88%	100%	100%	100%	100%	98%	97% circular
Total $\bar{X}$ Reliability	100%	98%	97%	100%	99%	94%	97%	100%	99%	100%	98%	99%

TABLE 3

Reliability by Tracking
Pathway for Subject 3

Paths	Sessions										Total $\bar{X}$ Reliability	
	1	2	3	4	5	6	7	8	9	10	by path	by plane
→	67%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97%	99% horizontal
↑	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
↘	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
↖	100%	100%	100%	100%	100%	67%	100%	100%	100%	100%	97%	98% diagonal
↗	100%	100%	67%	100%	100%	100%	100%	100%	100%	100%	97%	
↙	100%	100%	100%	100%	100%	67%	100%	100%	100%	100%	97%	
→	67%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97%	99% vertical
↓	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
↻	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
G	88%	88%	100%	100%	75%	100%	100%	100%	88%	100%	94%	97% circular
Total $\bar{X}$ Reliability	92%	99%	97%	100%	98%	93%	100%	100%	99%	100%	96%	98%

TABLE 4

Reliability by Tracking
Pathway for Subject 4

Paths	Sessions										Total $\bar{X}$ Reliability	
	1	2	3	4	5	6	7	8	9	10	by path	by plane
→	100%	100%	67%	100%	100%	100%	100%	100%	100%	100%	97%	99% horizontal
↑	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
↗	100%	100%	100%	100%	67%	100%	100%	100%	100%	100%	97%	98% diagonal
↖	67%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97%	
↘	100%	67%	100%	100%	100%	100%	100%	100%	100%	100%	97%	100% vertical
↓	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
↙	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
↻	100%	100%	88%	100%	88%	100%	88%	88%	100%	100%	95%	97% circular
↺	100%	100%	100%	100%	100%	100%	100%	88%	88%	100%	97%	
Total $\bar{X}$ Reliability	97%	97%	96%	100%	96%	100%	99%	98%	99%	100%	98%	99%

had the highest score of 100% while the circular paths had the lowest score of 97%. The mean reliability for sessions was 98%.

All Subjects. As shown in Table 5, the total mean reliability for all four planes across subjects was 98%. The circular plane had the lowest reliability with a mean score of 96%, while horizontal, vertical and diagonal planes all had mean reliability scores of 99%.

Performance Data

Subject 1. Figure 1 shows the percent of horizontal, diagonal, circular, and vertical sections tracked by Subject 1 over ten sessions. Performance scores varied the least with the diagonal and horizontal planes, ranging from 83-100% of the sections tracked. The percent of sections tracked for the vertical planes varied from 50-100%, while the circular paths were tracked from 56-100% of the time.

Subject 2. The performance scores for Subject 2 are shown in Figure 2. Scores ranged from 50-100% for the horizontal paths, from 17-100% for the vertical paths, from 50-100% for the diagonal paths and from 44-100% on the circular paths.

Subject 3. As shown in Figure 3, a wide range of performance scores were obtained from Subject 3. These scores ranged from 33-100% for the horizontal paths, and 0-100% for the vertical paths, from 50-100% for the diagonal planes and from 12-88% for the circular paths.

Subject 4. The performance scores for the nonhandicapped infant are shown in Figure 4. The infant was 8 weeks old at the beginning of the study and 18 weeks old when the last observation was conducted. During this time tracking abilities for the horizontal plane went from 0% to 100%, from 17% to 100% for the vertical paths, from 25% to 75% for the diagonal paths, and from 0% to 94% for the circular paths.

TABLE 5

Mean Reliability of Ten Observations of Visual Tracking
by Subject and Tracking Pathway

Paths	Subject				Total $\bar{X}$ Reliability	
	1	2	3	4	by path	by plane
→	100%	97%	100%	97%	99%	99% horizontal
←	97%	100%	100%	100%	99%	
↗	100%	100%	100%	97%	99%	
↖	100%	97%	97%	97%	98%	99% diagonal
↘	100%	97%	97%	97%	98%	
↙	100%	97%	100%	100%	99%	
↑	97%	97%	100%	100%	99%	99% vertical
↓	97%	100%	97%	100%	99%	
↻	94%	100%	95%	95%	96%	
⊙	95%	94%	98%	98%	96%	96% circular
Total $\bar{X}$ Reliability	99%	99%	98%	98%	98%	98%

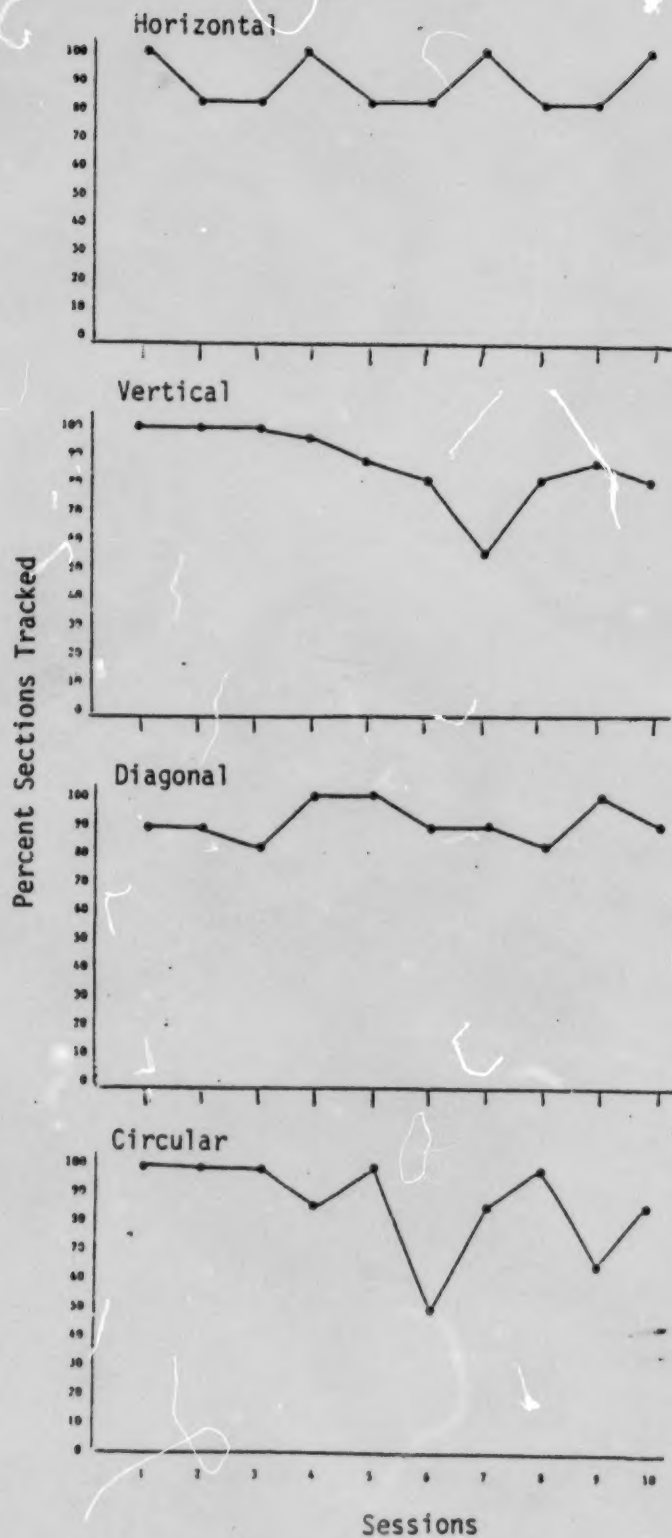


Figure 1. Percent sections tracked across planes for Subject 1

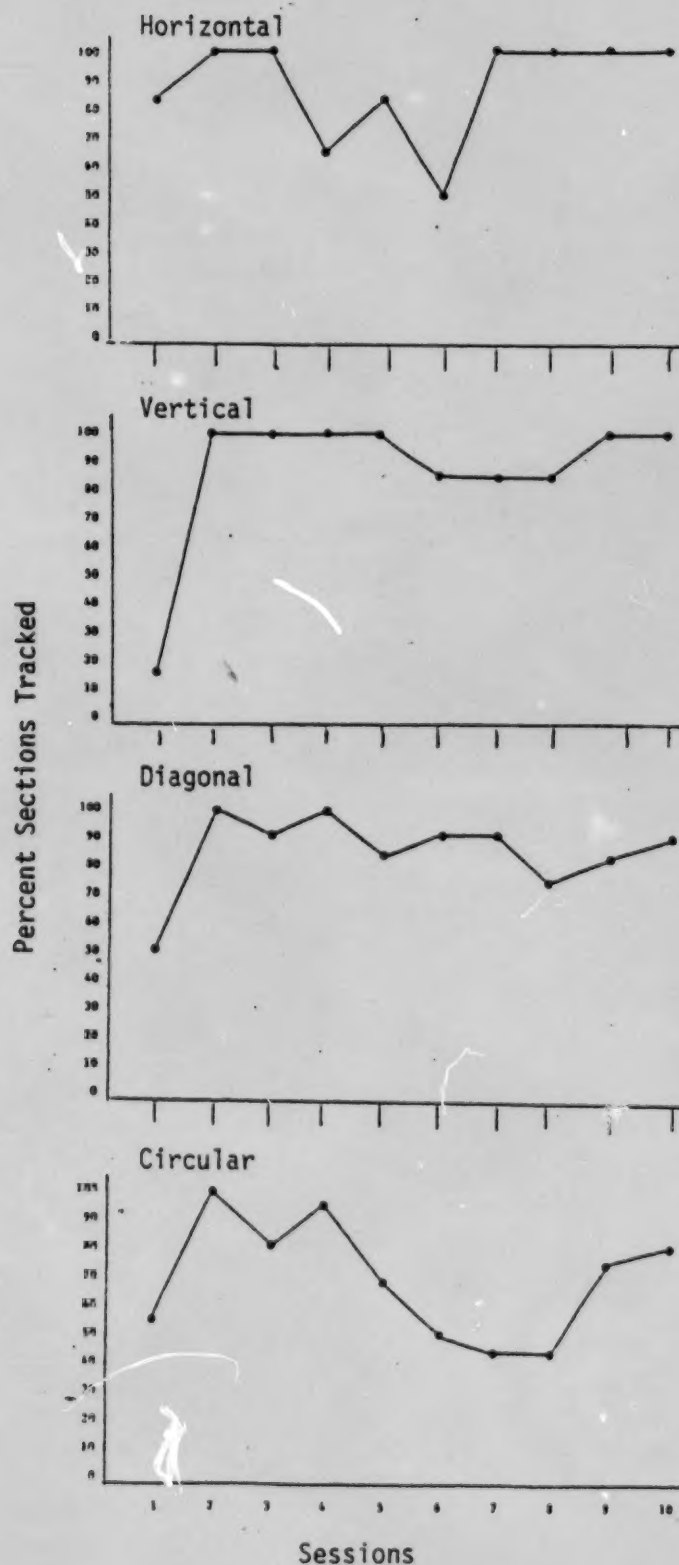


Figure 2. Percent sections tracked across planes for Subject 2

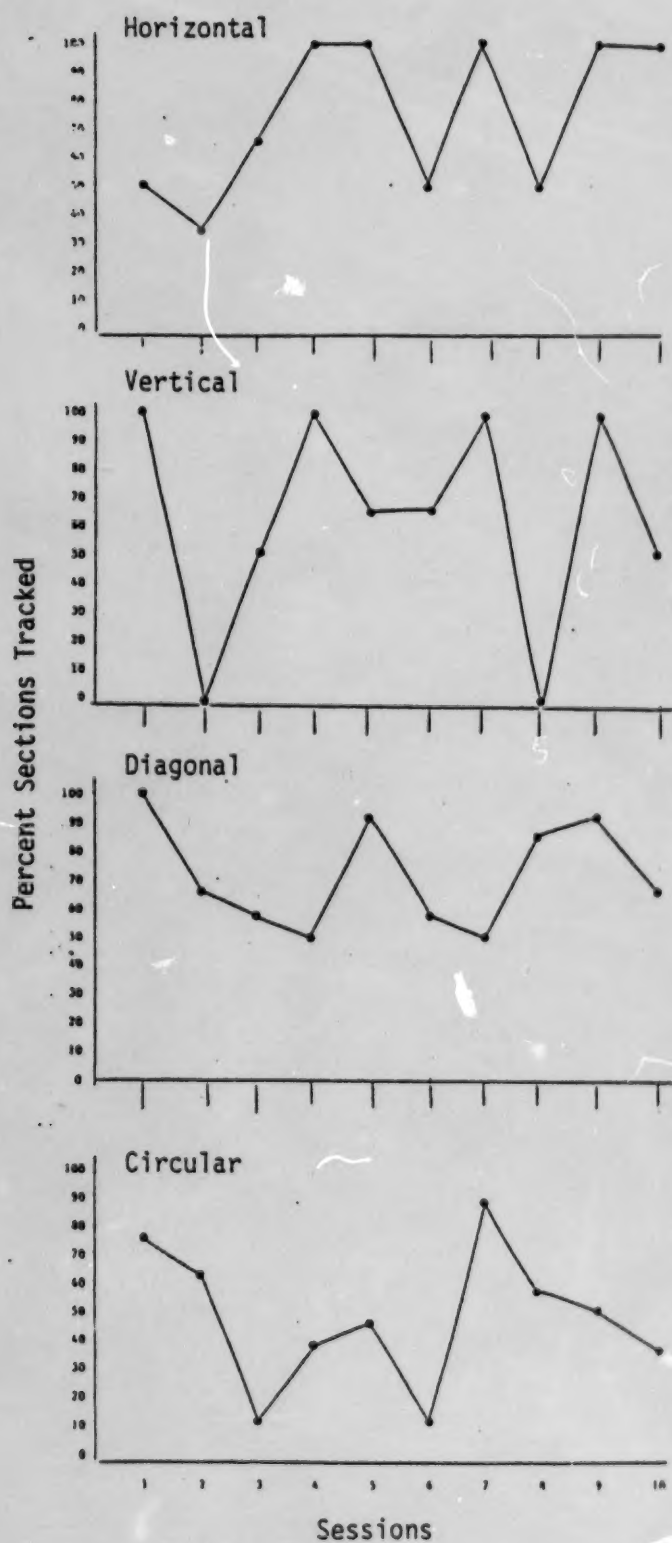


Figure 3. Percent sections tracked across planes for Subject 3

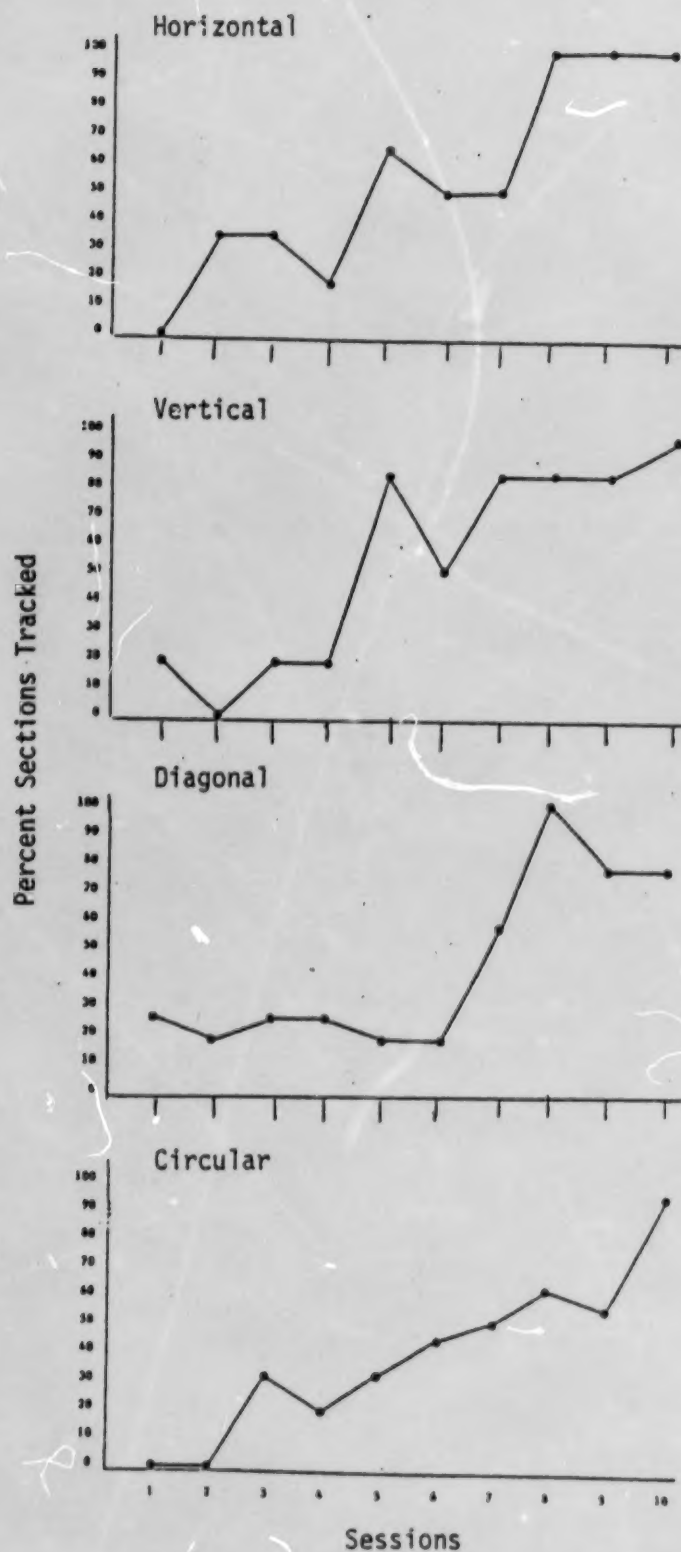


Figure 4. Percent sections tracked across planes for Subject 4

All Subjects. Figure 5 shows the total percent of sections tracked over ten sessions for all four subjects. Subject 1 had the most consistent scores ranging from 78-98%. Total performance scores for Subject 2 ranged from 53-100%, while Subject 3's scores ranged from 40-83%. Subject 4, the nonhandicapped infant, went from tracking 10% of the total sections to 90%.

Discussion

The measurement procedures were proven to be reliable across subjects and tracking pathways. The total mean reliability score across all conditions was 98%. This score was only slightly higher than the mean reliability score of 95% obtained in the original study under similar conditions. As with the original study, the circular paths were found to be the least reliable, while the horizontal, vertical and diagonal planes showed no observable difference. Although all subjects for this study were tested in a sitting position, the original study demonstrated that these procedures were also reliable with subjects tested in prone and sidelying positions, thus allowing for various physical limitations of each subject.

The performance scores for Subject 4 (nonhandicapped infant) indicated that these measurement procedures are effective in measuring small increments of change as visual tracking skills emerge. According to normative data (Gesell, 1928 and 1938; Buhler, 1930; Cattell, 1940; Griffiths, 1954; and Bayley, 1969) the performance for Subject 4 was somewhat delayed. However, this was most likely due to the testing position of the infant during this study. Due to lack of sufficient head control, the infant was unable to raise her head high enough to look at the stimulus object which was held up to a section on the top row of the grid. Fixation on the stimulus items occurred more frequently when the object was in one of the sections on the bottom row. Thus, testing the child in sidelying or prone position might have enabled the infant to look at the stimulus items more easily.

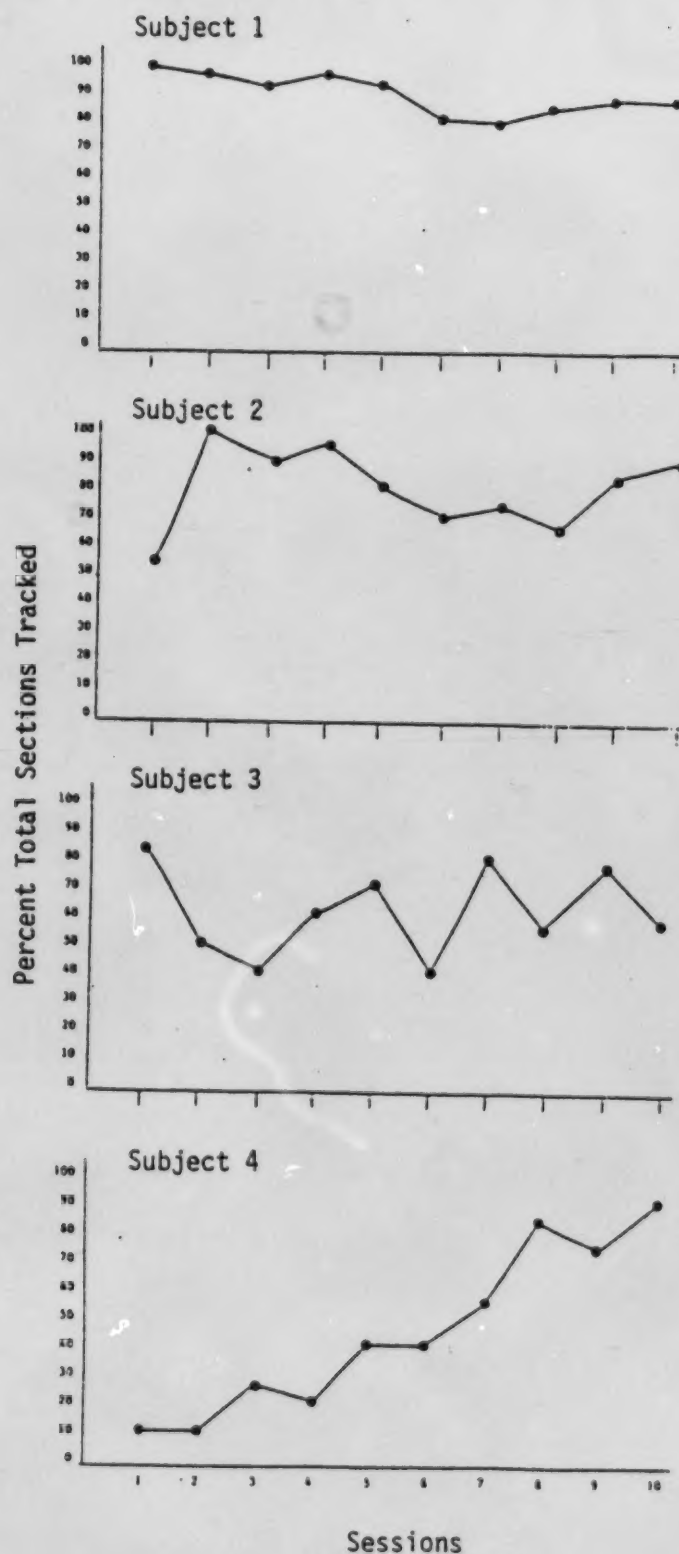


Figure 5. Percent sections tracked for combined planes across sessions for all subjects

The revised measurement procedures were shown to be very time efficient. Measuring tracking skills at only one distance enabled the examiner to complete most sessions in less than eight minutes. Exceptions of this were most typically observed, in the first four sessions, with the nonhandicapped infant. During this time, intervals were needed for bottle feeding and resting, resulting in sessions lasting up to 30 minutes. However, by the age of 12 weeks, sessions were conducted without such interruptions.

The handicapped subjects were tested in the classroom with the para-professionals serving as reliability assistants. Minimal instructions were needed to familiarize the assistants with procedures, which indicates that the scoring system was easy to understand and simple to use. The plexiglass grid, the only unique feature required by these procedures, was inexpensive and easy to assemble.

This longitudinal study provides data indicating that this assessment could serve as a valuable tool for the classroom teacher. First, it would enable the teacher to adequately determine the visual tracking skills of a student by specific pathways. By pinpointing weaknesses in this area, the teacher would be able to focus only on those pathways that needed training. These measurement procedures would also serve as an excellent means of measuring the student's progress throughout the school year. Furthermore, knowing a student's preference for tracking pathways might have a significant effect on how stimulus items should be positioned for other program areas such as preacademic and prevocational. Finally, a space is provided on the comment section in which the teacher can make note of specific problems such as difficulty crossing midline or tracking with only one eye. This type of information would help the teacher in recognizing certain problems that might otherwise be overlooked.

The major problem encountered in this study was in obtaining consistent performance scores from the subjects. This would indicate that a teacher would need to assess the child on a consistent basis throughout the year to adequately determine progress in visual tracking skills. Another suggestion for the use of this assessment would be to derive a mean score for each plane by conducting three sessions. This would provide more trials giving more precise information concerning a child's visual tracking abilities.

This study showed that the revised measurement method was reliable, easy to administer and effective in detecting small increments of change. However, further studies should investigate the implementation of this tool within a total assessment package in a classroom setting. This type of research would also provide information concerning effective ways in which visual skills could be trained functionally and monitored throughout the school year.

A REPLICATION STUDY:
Quantitative Assessment of Visual Scanning Skills Among
Severely Handicapped and Nonhandicapped Infants and Children¹

by
Liz Vogt
and
Cynthia M. Janssen

¹The procedures and data reported in this study were taken from a Master's thesis by Liz Vogt that was submitted to the Department of Special Education, University of Kansas, in January, 1982.

Overview of Measurement Procedures

A complete description of the measurement procedures used in this study is found in pages V0(S) 1 to V0(S) 14 of Volume I, Assessment Procedures for Selected Developmental Milestones. Procedures were developed to measure the frequency and mean frequency of visual contacts with preferred objects in the scan path when the student was in a sitting, prone, or sidelying position. Scan path was defined as the grid sections which the student's eyes visually contacted. A 3' x 3' plexiglass grid, divided into nine sections, was used to arrange stimulus items into various arrays: two objects horizontally, two objects vertically, two objects diagonally, three objects horizontally, three objects vertically, three objects diagonally, and three objects randomly placed. Each of these arrays was tested in two distances from the child: grid 6" - 12" from child and grid 18" - 24" from child. In the original study, it was reported that the distance of the grid did not significantly affect either the child's performance or the reliability, therefore one distance, grid 12" - 18" from child was used in this study.

For each trial the grid was masked and placed directly in front of the child with the examiner directly in front of the child and grid in order to clearly view the child's eyes. A trial began when the grid was unmasked and the student was instructed to look and ended after 15 seconds had elapsed. The frequency of visual contacts with each object in the array was recorded during each 15 second trial. In the original study each student was tested in at least two positions with four observation sessions per position. Since the procedures were found to be reliable in each of the three positions in the original study, each student was tested in only one position (sitting) for this replication.

An assessment session was conducted once every one to two weeks for a period of three months. The longitudinal data obtained from this assessment were collected to demonstrate that the procedure was reliable over time, as well as simple and quick to administer.

Subjects

This study included both multiply handicapped individuals and a nonhandicapped infant. Selection criteria included vision within functional limits and demonstration of minimal fixation and tracking abilities.

Subject 1. Heather was a 6 year old female with Down's Syndrome. She demonstrated pronounced delays in all curriculum domains. Language and social skills were assessed to be between 3-4 years according to the Brigance Diagnostic Inventory of Early Development and Portage Project Checklist and cognitive skills were assessed to range from 2-3 years. Ophthalmology reports indicated functionally normal vision although the left eye dominated and she lacked binocular depth perception.

Subject 2. Leslie was a 3 year old nonambulatory, nonverbal female with spastic athetoid quadraplegic cerebral palsy. According to the Portage Project Checklist she was functioning from 6-12 months in language and motor skills and at 3 years in cognitive skills and social skills. Assessment with the Brigance showed her to be functioning between 3-5 years cognitively. Ophthalmology reports indicated vision within normal limits.

Subject 3. Stephanie was a 5 year old nonambulatory, nonverbal female who was diagnosed as developmentally delayed and spastic diparesis with extreme tendencies in the lower parts of her body and legs. Assessment with the Portage Project Checklist indicated that she functioned from 2-8 months in all domains. Ophthalmology reports indicated vision within normal limits.

Subject 4. Beth was a normally developing female who was observed from 5-7 months of age.

Procedures for Obtaining Measures of Reliability

Reliability was computed and recorded for each trial of every session by two observers; the primary observer remained constant with all subjects while the second observer (paraprofessional, parent or university student) varied with each subject. The two observers were positioned adjacent to one another, with the grid between them so that the subject's face was clearly viewed from approximately the same distance and angle. Each observer recorded the frequency of visual scanning for each of the stimulus objects; objects not scanned were scored with a zero. Observers did not consult with each other during trials and the entire session was completed before computing the mean frequency of visual contacts or reliability between observers.

With the conclusion of a session, reliability was determined for each trial and for the complete session. The percentage of reliability for each trial was first computed for each object within the trial according to the following formula:

$$\frac{\text{number agreements}}{\text{number agreements} + \text{number disagreements}}$$

The percentages of reliability for each object were then added together and this total was divided by the number of objects within the trial. Reliability for objects not scanned (a score of zero) was included in the computation for the percentage of reliability for each trial. If both observers scored no visual contacts during a trial, then 100% reliability was obtained for that trial. If one observer scored a zero and the second observer scored 1 visual contact, then 50% reliability

was averaged for total session reliability. Percent reliability scores for trials were averaged together for the total session reliability.

Results

In this section interobserver reliability scores and performance data across ten sessions for all subjects are presented. Mean reliability scores are presented for each visual scanning array as are mean reliability scores over the 10 sessions. Figures for each subject's performance are presented for the mean frequency of visual contacts by arrays along with the mean frequency of visual contacts across sessions for each subject.

Reliability and percentage scores were computed to one decimal place and approximated to the nearest whole number. Frequency scores were computed to three decimal places and approximated to two decimal places.

Results by Subjects

Subject 1. The reliability scores for Subject 1 are presented in Table 1 by arrays and across sessions. The scores for each trial ranged from a reliability agreement of 50% to 100% with a mean reliability score of 97%. Mean reliability scores for each array ranged from 88% to 97%. Mean reliability scores across sessions ranged from 84% to 96%. Figure 1 displays the mean frequency of visual contacts by arrays for Subject 1. The mean frequency scores ranged from .90 visual contacts to 1.89 visual contacts.

Subject 2. The reliability scores for Subject 2 are presented in Table 2 by arrays and across sessions. The scores for each trial ranged from a reliability agreement of 67% to 100% with a mean reliability score of 94%. Mean reliability scores for each array ranged from 86% to

TABLE 1

Interobserver Reliability Scores by Visual Array Across Sessions for Subject 1

Visual Array	Sessions										Mean Reliability
	1	2	3	4	5	6	7	8	9	10	
2 - horizontal	50	100	100	100	100	100	100	100	100	100	95
3 - horizontal	78	100	83	100	100	100	67	100	83	83	89
2 - vertical	100	100	100	100	75	100	100	87	83	100	94
3 - vertical	67	89	89	67	72	100	93	100	100	100	88
2 - diagonal /	100	100	100	100	100	100	100	100	100	75	97
3 - diagonal /	100	89	100	89	83	75	89	78	67	87	94
2 - diagonal \	80	100	100	100	100	100	100	100	75	100	95
3 - diagonal \	83	100	100	83	80	100	83	100	67	100	90
Random	100	83	100	100	83	91	67	83	83	100	89
Mean Reliability	95	87	97	93	88	96	89	94	84	94	92

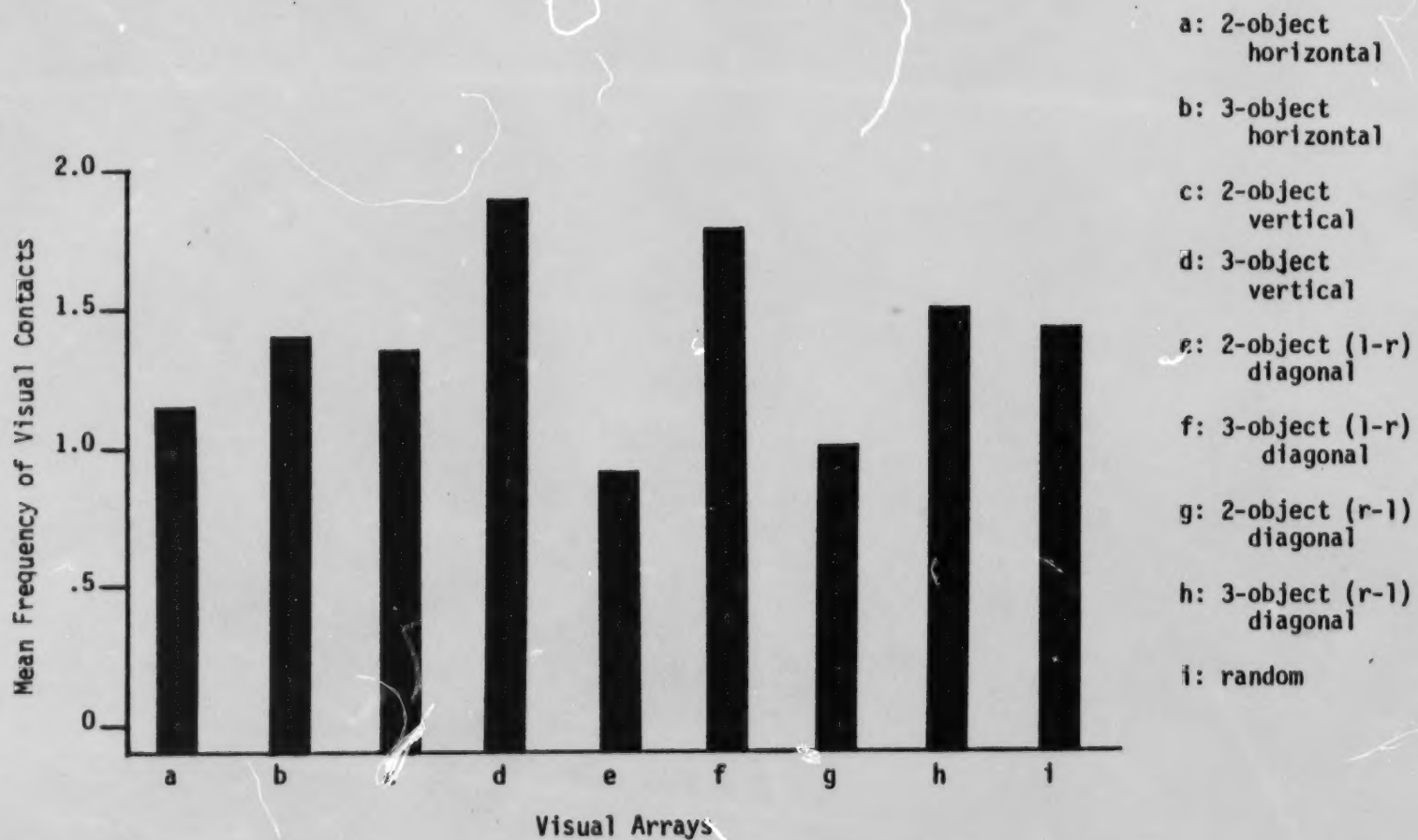


Figure 1: Mean Frequency of Visual Contacts by Arrays Across Ten Sessions for Subject 1

TABLE 2

Interobserver Reliability Scores by Visual Array Across Sessions for Subject 2

Visual Array	Sessions										Mean Reliability
	1	2	3	4	5	6	7	8	9	10	
2 - horizontal	100	100	100	100	100	100	100	100	100	100	100
3 - horizontal	100	100	100	100	100	100	61	83	100	83	93
2 - vertical	87	100	100	100	100	100	100	100	100	100	99
3 - vertical	81	83	100	100	67	100	64	100	100	83	88
2 - diagonal /	100	100	100	100	100	100	100	75	87	100	96
3 - diagonal /	89	72	100	100	100	100	100	83	100	83	93
2 - diagonal \	100	100	100	100	100	100	100	83	100	100	98
3 - diagonal \	100	89	89	100	100	75	67	100	100	44	86
Random	100	100	100	100	100	100	100	100	83	83	97
Mean Reliability	95	94	99	100	96	97	88	91	97	86	94

VO(S)8

100%. Mean reliability scores across sessions ranged from 88% to 100%. Figure 2 displays the mean frequency of visual contacts by arrays for Subject 2. The mean frequency scores ranged from .90 visual contacts to 1.5 visual contacts.

Subject 3. The reliability scores for Subject 3 are presented in Table 3 by arrays and across sessions. The scores for each trial ranged from a reliability agreement of 61% to 100% with a mean reliability score of 96%. Mean reliability scores for each array ranged from 93% to 100%. Mean reliability scores across sessions ranged from 92% to 100%. Figure 3 displays the mean frequency of visual contacts by arrays for Subject 3. The mean frequency scores ranged from .70 visual contacts to 1.23 visual contacts.

Subject 4. The reliability scores for Subject 4 are presented in Table 4 by arrays and across sessions. The scores for each trial ranged from a reliability agreement of 61% to 100% with a mean reliability score of 96%. Mean reliability scores for each array ranged from 91% to 100%. Mean reliability scores across sessions ranged from 88% to 100%. Figure 4 displays the mean frequency of visual contacts by arrays for Subject 4. The mean frequency scores ranged from .60 visual contacts to 1.33 visual contacts.

Results for All Subjects

Mean reliability scores for all subjects by sessions are presented in Table 5. Scores ranged from 87% to 100% with a mean score of 94% across four subjects. Table 6 presents the mean reliability scores for visual arrays for all subjects. Scores range from 86% to 100% with a mean score of 94% across all subjects. Figure 5 presents the mean frequency of visual contacts across 10 sessions for each subject.

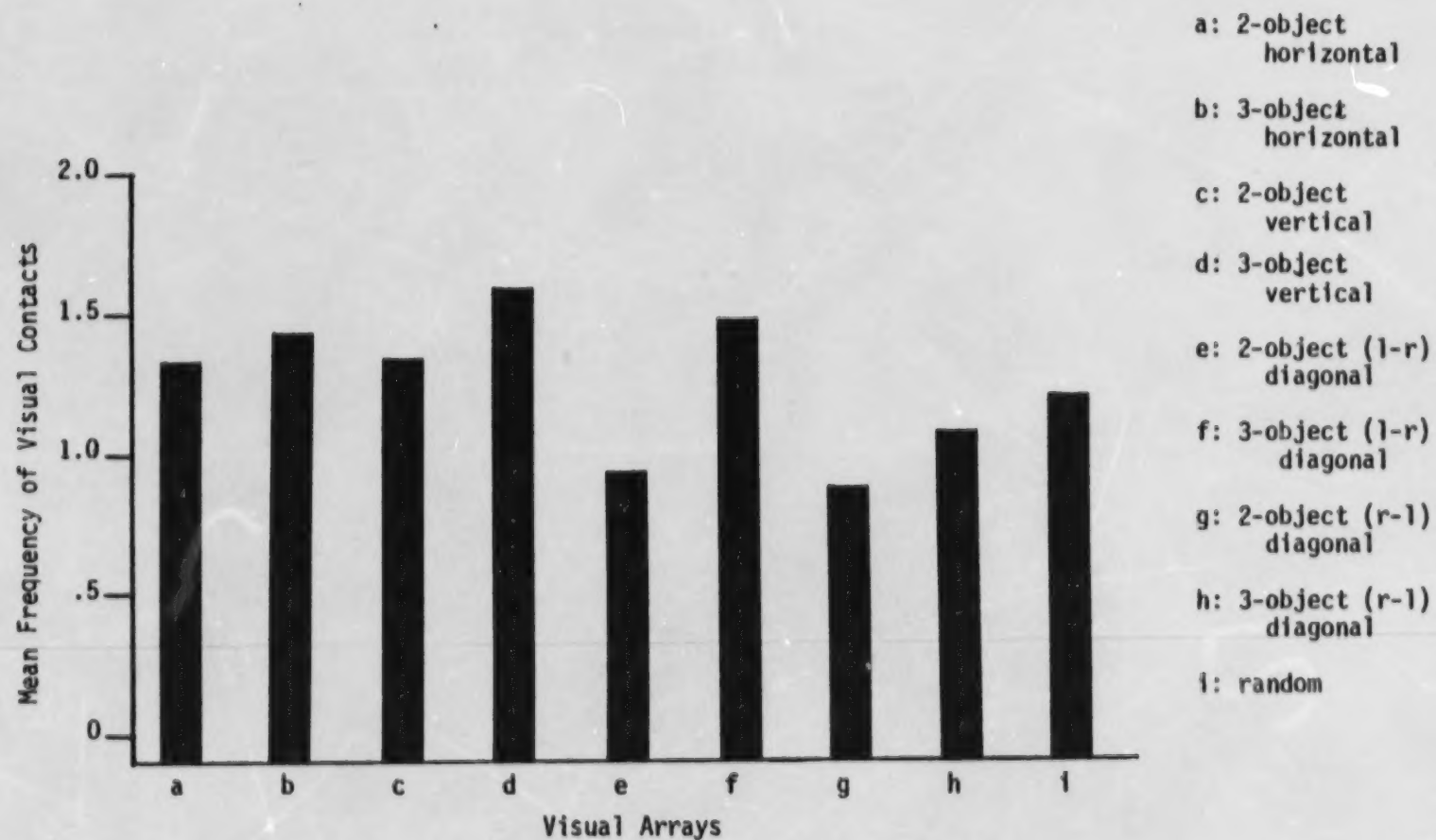


Figure 2: Mean Frequency of Visual Contacts by Arrays Across Ten Sessions for Subject 2

TABLE 3

Interobserver Reliability Scores by Visual Array Across Sessions for Subject 3

Visual Array	Sessions										Mean Reliability
	1	2	3	4	5	6	7	8	9	10	
2 - horizontal	100	100	100	100	100	100	100	100	75	100	97
3 - horizontal	100	89	100	83	100	100	100	100	100	100	97
2 - vertical	100	100	100	100	100	100	100	100	100	75	97
3 - vertical	100	83	83	100	100	100	100	100	100	83	95
2 - diagonal /	100	100	100	100	100	100	100	100	100	100	100
3 - diagonal /	83	100	83	82	100	100	100	100	100	100	95
2 - diagonal \	100	75	100	100	100	100	100	100	100	100	97
3 - diagonal \	100	93	89	93	100	100	100	61	100	100	94
Random	100	89	89	100	100	89	83	83	100	100	93
Mean Reliability	98	92	94	95	100	99	98	94	97	95	96

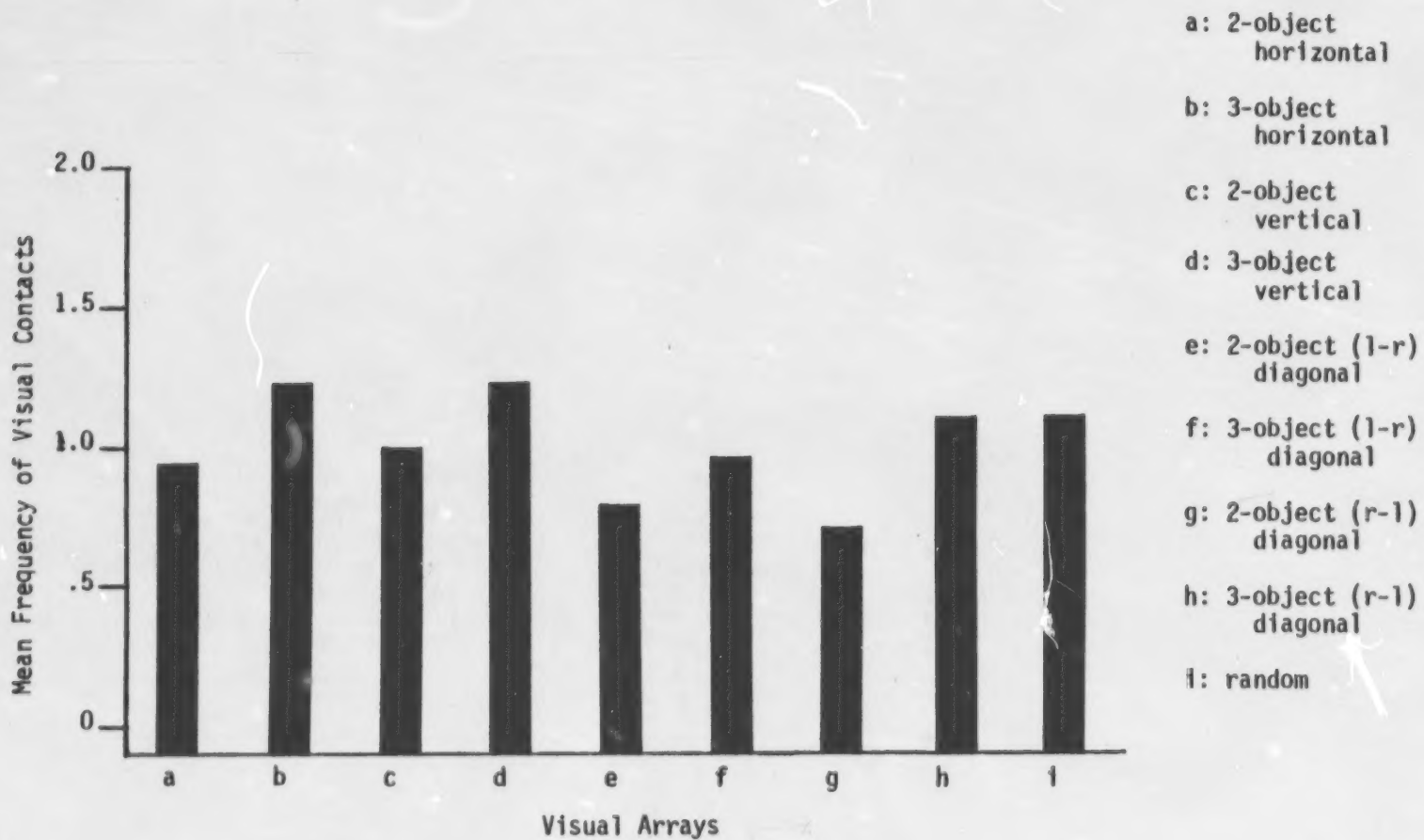


Figure 3: Mean Frequency of Visual Contacts by Arrays Across Ten Sessions for Subject 3

TABLE 4

Interobserver Reliability Scores by Visual Array Across Sessions for Subject 4

Visual Array	Sessions										Mean Reliability
	1	2	3	4	5	6	7	8	9	10	
2 - horizontal	100	100	100	100	100	100	100	100	100	75	97
3 - horizontal	100	100	100	100	100	83	100	89	100	100	97
2 - vertical	100	100	100	100	100	100	100	80	100	100	98
3 - vertical	100	100	100	100	72	100	100	61	100	85	92
2 - diagonal /	100	100	100	100	100	100	100	100	100	100	100
3 - diagonal /	87	100	100	83	83	100	77	100	100	100	93
2 - diagonal \	100	100	100	100	100	100	100	100	100	100	100
3 - diagonal \	100	100	61	83	100	100	100	72	92	100	91
Random	100	100	100	100	83	83	100	93	100	89	95
Mean Reliability	98	100	96	96	93	96	97	88	99	94	96

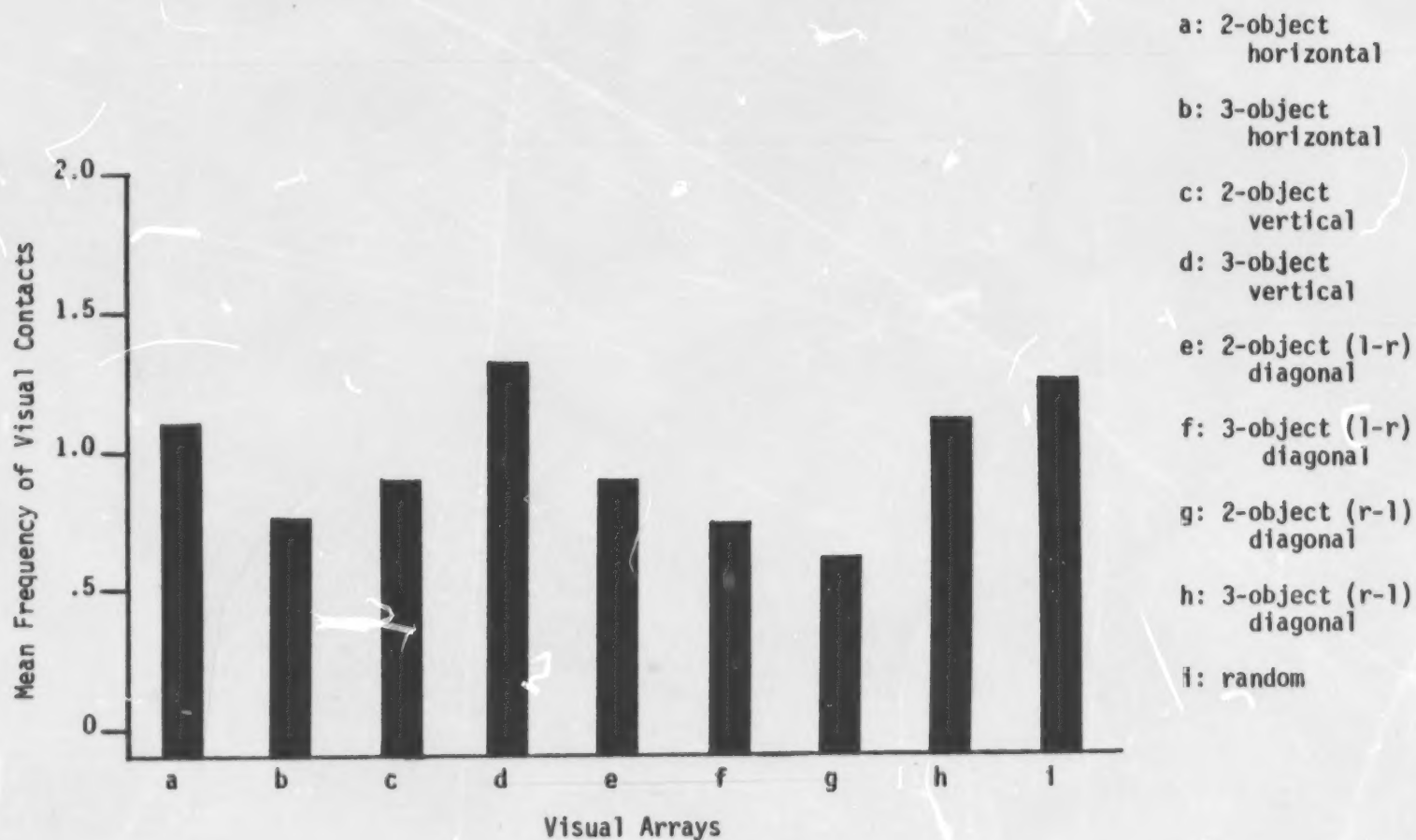


Figure 4: Mean Frequency of Visual Contacts by Arrays Across Ten Sessions for Subject 4

TABLE 5

Mean Reliability Scores for All Subjects Across Sessions

Subject	Sessions										Mean Reliability
	1	2	3	4	5	6	7	8	9	10	
1	95	87	97	93	88	96	89	94	84	94	92
2	95	94	99	100	96	97	88	91	97	86	94
3	98	92	94	95	100	99	98	94	97	95	96
4	98	100	96	96	93	96	97	88	99	94	96
Mean Reliability	96	93	96	96	94	97	93	92	94	92	94

TABLE 6

Mean Reliability Scores for All Subjects by Visual Array

Subject	Visual Arrays								Random	Mean Reliability
	2-	3-	2	3	2/	3/	2\	3\		
1	95	89	94	88	97	94	95	90	89	92
2	100	93	99	88	96	93	98	86	97	94
3	97	97	97	95	100	95	97	94	93	96
4	97	97	98	92	100	93	100	91	95	96
Mean Reliability	97	94	97	91	98	94	97	90	93	94

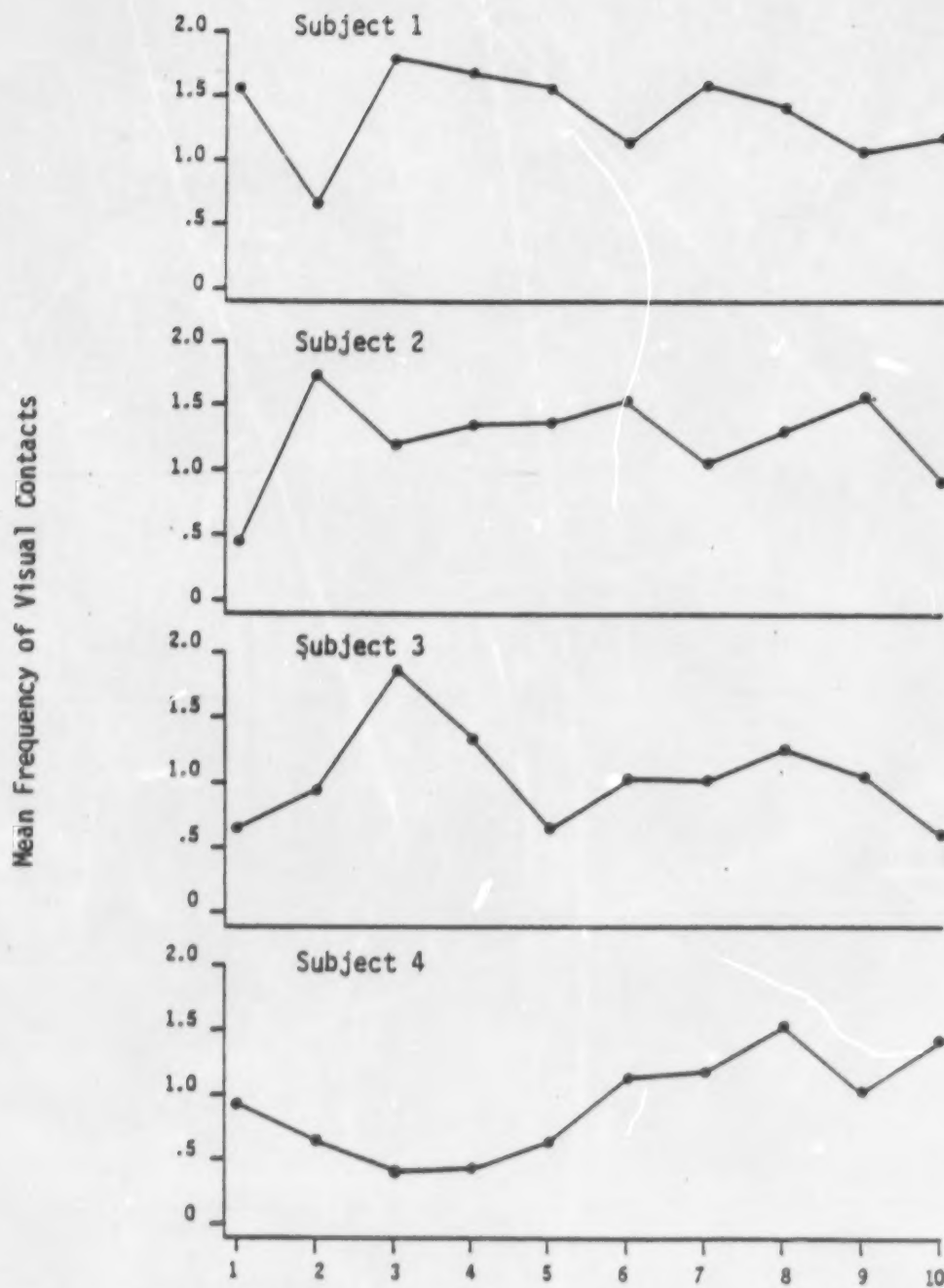


Figure 5: Frequency of Visual Contacts Across Sessions for All Subjects

Discussion

In this section, measurement procedures and the results of interobserver reliability will be reviewed and compared to the original study conducted by Fernandez. The scanning performance of each subject is discussed and condensed, and extended studies are proposed with these procedures. The data with these four subjects suggests that several variables may affect the frequency of visual scanning. Specific arrays and the number and type of objects presented may elicit scanning. Visual impairments and cognitive development show a logical correlation to the frequency of visual scanning.

As with the initial study, this study limited the number of preferred objects and used these items to both elicit and reinforce scanning behavior. Reinforcement consisted of allowing the subject to interact functionally with the object scanned most frequently. Objects that were extremely reinforcing to specific subjects were apparently promoting a high frequency of scanning.

Procedures for measuring visual scanning were demonstrated to be reliable across subjects, sessions, and arrays. All subjects were tested in a sitting position with a mean reliability of 94% across sessions and of 94% across arrays. The original study by Fernandez, with subjects tested in sitting, sidelying and prone positions, obtained a mean reliability score of 97% across all positions, 97% across all arrays and 97% across all sessions. Although Fernandez measured visual scanning for both near and far distances as opposed to one distance for this study no major variations of interobserver reliability were observed.

Fernandez noted that the extent of the handicapped subjects' visual impairments could have affected the examiner's perception of where the

subject scanned, however reliability scores negated this. All subjects in this study were found to have vision within normal limits. The mean frequency of scanning, with subjects in which vision was not impaired, was higher than in the original study. The mean frequency scores across all subjects in the study by Fernandez ranged from .31 to 1.31. The mean frequency scores across all subjects in this study ranged from .60 to 1.89. The data indicate that higher frequency of scanning does not impair reliability.

The reliability score for Subject 1 across all sessions was computed at 92%, slightly lower than the mean score of all subjects across sessions. The mean frequency of visual scanning across all arrays was 1.37. Performance varied with low frequencies of .90 for the 2-object left-right diagonal array and 1.0 for the 2-object right-left diagonal array, to high frequencies of 1.77 for the 3-object left-right diagonal and 1.89 for the 3-object vertical array. Variations in performance scores across sessions did not indicate skill acquisition for Subject 1.

The mean reliability score for Subject 2 across all sessions was computed at 94%. The mean frequency of visual scanning across all arrays was 1.26. The data indicated 2 arrays with low frequencies: a frequency of .90 for the 2-object right-left diagonal array and .95 for the 2-object left-right diagonal array. The highest scores for Subject 2 were frequencies of 1.50 for the 3-object left-right diagonal array and 1.60 for the 3-object vertical array. Variations in performance scores across sessions did not indicate skill acquisition for Subject 2.

The reliability score for Subject 3 across all sessions was computed at 96%, slightly higher than the mean score of all subjects across sessions. The mean frequency of visual scanning across arrays was 1.00.

Lowest frequencies of scanning arrays were .70 contacts for the 2-object right-left diagonal and .80 contacts for the 2-object left-right diagonal. Highest frequencies were equal with 1.23 contacts for both the 3-object vertical and the 3-object horizontal arrays. Variations in performance scores across sessions did not indicate skill acquisition for Subject 3.

The mean reliability score for Subject 4, the nonhandicapped subject, was computed at 96% across all sessions, slightly higher than the mean score of all subjects across sessions. The mean frequency of visual scanning across arrays was .96. Three distinct low frequencies of scanning arrays were noted: .60 for the 2-object right-left diagonal array, .73 for the 3-object left-right array and .76 for the 3-object horizontal array. The arrays with the highest frequency of scanning were 1.23 for the 3-object random array and 1.33 for the 3-object vertical array. Data across sessions indicated skill acquisition. An initial mean frequency of .92 was followed by four sessions with lower scores, and five final sessions which showed increasing scanning behavior.

Review and comparison of subject performance indicates specific arrays across subjects that promoted and deterred visual scanning. The mean frequency was determined by dividing the total frequency of contacts with stimulus objects by the number of objects in the array. A higher number of objects per trial does not result in a higher mean frequency of visual scanning, however, the two most frequently scanned arrays were those with 3 objects and the two least frequently scanned arrays were those with 2 objects.

The 3-object vertical array promoted the highest mean frequency of scanning contacts: Subject 1 scanned at a mean of 1.89, Subject 2 at 1.60, Subject 3 at 1.23, and Subject 4 at 1.33. The second most fre-

quently scanned array was the 3-object left-right diagonal array: Subject 1 scanned at a mean frequency of 1.77 and Subject 2 at 1.50. The 3-object random array was the second selection of Subject 4 at a mean frequency of 1.23 scanning contacts. Subject 3 indicated an equal number of scanning contacts with a mean frequency of 1.23 when scanning the 3-object horizontal array as well as the 3-object vertical array.

The array with the lowest mean frequency of scanning was the 2-object right-left diagonal array: Subject 2 scanned at a mean of .90, Subject 3 at .70, and Subject 4 at .60. This array was the second least preferred by Subject 1 with a mean frequency of 1.00 visual contacts. The 2-object left-right diagonal also deterred visual scanning: Subject 1 scanned at a mean of .90, Subject 2 at .95 and Subject 3 at .80.

It can be concluded that the number of objects and the array design affect the frequency of visual scanning. While the 3-object array, with an object in a center grid section, promoted scanning, scoring seemed more difficult because the subject's face was not fully viewed at all times. The mean reliability score for the 3-object vertical array was 91% and for the 3-object left-right diagonal array the reliability score was 94%. The 2-object arrays with low frequency scanning were found to be more reliably scored with 98% for the 2-object right-left array and 97% for the 2-object left-right array. One possible conclusion which can be drawn is that the centered stimulus objects elicited higher scanning frequencies by gaining the immediate attention of the subject and/or that a 2-object array lacked visual continuity.

Cognitive development was examined as a correlate to the frequency of scanning. Subject 1 was assessed as functioning from the 2-5 year level cognitively and scanned at a mean frequency of 1.37 contacts per

array. Subject 2 was assessed to be functioning at the 3 year level in cognitive development and scanned at a mean frequency of 1.26 contacts per array. Subject 3 was assessed to be functioning from 2-8 months cognitively and scanned at a mean frequency of 1.00 contacts per array. Subject 4, the nonhandicapped infant was observed from 5-7 months of age and scanned at a mean frequency of .96 contacts per array.

In the original study, Fernandez suggested changing or increasing the variety of the stimulus items to prevent boredom with the nonhandicapped individuals. Ten items, which included edibles, were used in the initial study. Twelve non-edible items were used in this study and it was found that handicapped subjects and the nonhandicapped subject responded in a similar fashion to the stimuli when presented as reinforcers at the end of each trial.

These measurement procedures should be used to collect further data on both handicapped and nonhandicapped subjects on a longitudinal basis. These data will provide information about acquisition rate and visual patterns. Simultaneous data collection on both populations will indicate similarities and/or differences in the development of this visual skill. Future research could also indicate whether or not the vertical plane is optimal for presenting the grid, or whether it should be presented on a horizontal plane.

Continuous application of these measurement procedures could provide teachers with a more sensitive measure to determine the effectiveness of their teaching strategy. Such measures as scanning percentages and mean frequencies by visual array would indicate visual patterns that teachers could use in all other training, i.e., presentation of stimulus items for discrimination training, etc.

As other sensory motor measurement methods are developed it can be determined whether one skill is influenced by the acquisition of other behaviors. This will indicate whether or not skills follow a maturationally determined sequence of development. It will require the continuous measurement of all the subcomponent parts in a sequence from the initial skill, i.e., visual fixation, through the terminal skill, i.e., visual scanning.

Additionally, longitudinal collection and analysis of data on visual scanning is necessary in order to determine whether or not this measurement system is more sensitive to the emergence and development of skills than the standardized and criterion-referenced assessments presently available to teachers of this population.

In summary, this study showed that the revised measurement method was reliable, easy to administer, and effective in detecting growth in the nonhandicapped subject. Further studies should investigate the implementation of this tool within a total assessment package in a classroom setting and provide information concerning effective ways in which visual skills could be trained functionally and monitored throughout the school year.

A REPLICATION STUDY:

Quantitative Assessment of Reach Among
Severely Handicapped and Nonhandicapped Infants and Children¹

by
Judy Cutsinger
and
David Esquith

¹The procedures and data reported in this study were taken from a Masters' thesis by Judy Cutsinger that was submitted to the Department of Special Education, University of Kansas, in February, 1982.

Overview of Measurement Procedures

A complete description of the measurement procedures used in this study is found in pages FM(R)1 to FM(R)38 of Volume I, Assessment Procedures for Selected Developmental Milestones. Procedures were developed to measure reach in the sitting, sidelying, supine, and standing position. Reach was measured by the occurrence or nonoccurrence of movement and contact with the stimulus object, the type of movement utilized, the use of the support of the resting surface if contact is made, the duration of the arm movement, and the arms utilized in the movement.

Each session consisted of 18 trials, divided into three trials for each of the six stimulus positions: right far, right near, mid far, mid rear, left far, and left near.

Two methods were used to elicit a reach response. The method was a verbal cue and the second was periodic activation of the stimulus item (every 3-4 seconds) to prompt the child to reach for the object. If the reach movement occurred and resulted in contact with the stimulus object, the observation then measured the directness or indirectness of the movement, the amount of support from the testing surface, the duration of the movement and the arm or arms utilized. If the reach movement occurred and did not result in contact with the stimulus object, the observation then measured the duration of the movement without contact up to a maximum time limit of two minutes and the arm or arms utilized. If no movement occurred whatsoever, the observation simply measured the duration of the nonmovement up to a maximum time limit of 15 seconds and the nonoccurrence of movement in either arm.

The stimulus objects (toys) were presented at two distances and at three angles from the child's body in each body position. The procedures

suggest that each child be evaluated in the body position(s) most appropriate to his or her current level of functioning. Although all four subjects in this study used the independent or supported sitting position, the procedures for measuring reach in the sidelying, supine, and independent or supported standing positions are described in Volume I.

Size of the stimulus objects were limited to 5" x 5" x 5". Each trial was timed using a stopwatch. There was a 15 second stimulus presentation time limit if no movement occurred or movement was stopped for at least two seconds prior to 15 seconds. Otherwise the session continued and the duration of movement was taken until contact was made or until movement stopped for at least two seconds. Each trial was monitored by a second person using a stopwatch.

Structured or unstructured environments with materials attractive to the child yet of a specified size were suggested as settings for the assessment. The assessment trials were delineated by specific cues, presentation of stimulus items and determination of the end of a trial.

The present study did not change the methods used to elicit a reach response, however, several changes were made in Proctor's procedures to observe and score the response. First, the near stimulus positions were changed from one-half to three-quarters the length of the child's arm. Second, when scoring the "movement-no contact" descriptor, the "direct or indirect" movement of the reaching hand(s) was not simultaneously recorded. Also, if movement without contact continued for two minutes or more, the stopwatch was stopped at the end of two minutes of uninterrupted movement. Thus, the "on surface" descriptor was scored if the child's hand and/or arm touched or slid across the testing surface at any point prior to contacting the stimulus.

Subjects

The handicapped subjects used for this study were all classified as severely mentally handicapped according to the Kansas State Special Education Guidelines. They were enrolled at the Kansas Neurological Institute (KNI) Special Purpose School. The normally developing infant was a nephew of the examiner. Selection of subjects was based on an assessed developmental age under 12 months and a lack of a mature well-developed reach pattern.

Subject 1. Brian was a 12 year old boy with a diagnosis of moderate hypotonic quadriplegia, partial blindness, seizure disorder, secondary macrocephaly, and no speech. He was non-ambulatory, but could stand in a standing table for short periods of time and could sit in a modified wheelchair. He did not grasp and release objects nor did he engage in object exploration. On the Bayley Scales of Infant Intelligence, Brian received a mental age equivalent of less than two months. On the Vineland Social Maturity Scale and the KNI Developmental Checklist he was functioning between the three and six month levels. Brian was classified as profoundly retarded in both measured intelligence and adaptive behavior.

Subject 2. Amber was a nine year old girl with a diagnosis of mild spastic diplegia, convulsive disorder, genetic disorder, secondary microcephaly, no speech and psychiatric impairment. Amber also appeared to have a hearing loss. She could grasp and release objects. Amber engaged in object exploration by mouthing objects or knocking them on the floor. She was ambulatory and could sit at a table in a chair. Her intellectual functioning was reported to be within the profound range on the mental scale of the Bayley Scales of Infant Development. Her adaptive behavior level ranged from severe to profound level as assessed on the Vineland Social Maturity Scale and KNI Developmental Checklist.

Subject 3. Jennifer was a 13 year old girl with a diagnosis of severe spastic diplegia, focal seizure disorder, slight visual impairment and no speech although she emitted a variety of sounds. She could grasp and release objects, but did not actively engage in exploration of objects. Jennifer was not ambulatory, but could sit in a modified wheelchair. On the Bayley Scales of Infant Development Jennifer received a mental age equivalent of less than six months. On the KNI Developmental Checklist she received a developmental age of nine months and on the Vineland Social Maturity Scale a social age of 10 months. Jennifer functioned at the profound level of retardation both intellectually and adaptively.

Subject 4. Loren was a normally developing seven month old infant. He could not stand without support, but was able to sit independently in an infant chair. He could grasp and release objects.

Procedures for Obtaining Measures of Reliability

Reliability measure for the sitting position were taken through independent observation by the examiner and one other observer for each session with each subject. In the present study, the examiner was always this investigator. Reliability measure for the sessions with the handicapped children were taken by a trained observer. The trained observer was a person who had had formal training in an area that taught him to understand behavioral definitions, observe behavior and take data. This person had a background in behavior modification and human development. Reliability measure for the sessions with the normal infant were taken by an untrained observer, the infant's mother. Both the trained and the untrained observers were unbiased. Within the context of this study, an unbiased observer was someone not connected with the Early Childhood

Institute (ECI), University of Kansas, Lawrence, Kansas. Reliability measure reflected the percent of agreement on the occurrence of the behaviors observed.

One measure of reliability was taken. Mean percent of reliability per stimulus position was recorded for all descriptors. Agreements on occurrence of behaviors were compared to the examiner's data. Individual reliability scores per descriptor and per stimulus position were calculated in the following manner:

$$\frac{\# \text{ Agreements}}{\# \text{ Agreements} + \text{Disagreements}} \times 100 = \% \text{ of Reliability}$$

Individual trial scores per descriptor/stimulus position agreed upon by both the examiner and observer were totalled. The total number of agreements were then divided by the total number of individual trial scores (agreements + disagreements) recorded by both the examiner and observer to obtain the overall reliability score for that descriptor/stimulus position. Within the specific response class of movement: (no-movement/movement-no contact/ and contact), the total amount of "movement" trials equalled 30 trials per hand per stimulus position.

Results

Measures of Interobserver Reliability

The interobserver reliability data for each subject are presented in Table 1-4. The interobserver reliability data for all four subjects combined are presented in Table 5.

In Tables 1-5, the first column labeled "Stimulus Position" indicates the position from which the stimulus object was presented to the subject. The second column labeled "Hand" indicates the movement/nonmovement of the right or left hand. The third through eighth columns labeled "No Movement,"

"No Contact," "Contact," "Direct," "Indirect," "On Surface" and "Off Surface" present the mean percentage of interobserver reliability data for each behavior descriptor across stimulus positions and right or left hand. The ninth column labeled "R/L" presents the mean percentage of interobserver reliability data for the right and left hand taken separately across all behavior descriptors and stimulus positions. The tenth column labeled "Time" presents the mean percentage of interobserver reliability data for the right and left hand combined across all time intervals. The eleventh column labeled "Total" presents the mean percentage of interobserver reliability data for the right and left hand combined across all stimulus positions, behavior descriptors and time intervals. Moving vertically under each column to the boxes at the bottom of the page, the overall mean percentage of interobserver reliability data was presented for the thirty sessions of data reported for each descriptor across all stimulus positions and hands. The box in the bottom right hand corner is the overall mean percentage of reliability data across all stimulus positions, all behavior descriptors and all time intervals for each subject.

Subject 1 (Brian). Table 1 presents the interobserver reliability data for the measurement of reach for Subject 1 in the sitting position. When there was no movement of the right or left hand, the interobserver reliability data across stimulus positions ranged from 17% to 100% with an average of 77% and a middle score ranging from 80% to 83%. When there was movement of the right or left hand resulting in no contact with the stimulus positions reliability ranged from 30% to 100% with an average of 77% and a middle score ranging from 80% to 82%. When there was movement of the right or left hand that produced contact with the stimulus object, the interobserver reliability data across stimulus positions ranged from 50%

TABLE 1

Reliability Scores for Subject 1 in a Sitting Position

STIMULUS POSITION	HAND	NO MOVEMENT	NO CONTACT	CONTACT	DIRECT	INDIRECT	ON SURFACE	OFF SURFACE	R/L	TIME	TOTAL
RIGHT FAR	R	5/6 83%	12/14 86%	10/10 100%	NONE	10/10 100%	5/5 100%	4/5 80%	46/50 92%	10/12 83%	84/96 88%
	L	7/10 70%	15/18 82%	2/2 100%	NONE	2/2 100%	1/1 100%	1/1 100%	28/34 82%		
RIGHT NEAR	R	7/9 78%	9/10 90%	9/11 82%	NONE	9/11 82%	3/4 75%	5/7 71%	42/52 81%	11/12 92%	81/99 82%
	L	13/13 100%	12/16 75%	1/1 100%	NONE	1/1 100%	NONE	1/1 100%	28/35 80%		
MID FAR	R	9/10 90%	12/15 80%	5/5 100%	NONE	5/5 100%	3/3 100%	2/2 100%	36/40 90%	10/11 91%	87/93 94%
	L	11/11 100%	13/13 100%	6/6 100%	NONE	6/6 100%	3/3 100%	2/3 67%	41/42 98%		
MID NEAR	R	10/12 83%	10/13 77%	3/5 60%	NONE	3/5 60%	3/5 60%	NONE	29/40 73%	13/17 76%	87/111 78%
	L	4/10 40%	4/8 50%	11/12 92%	NONE	11/12 92%	7/8 88%	4/4 100%	45/54 83%		
LEFT FAR	R	4/7 57%	20/21 95%	1/2 50%	NONE	1/2 50%	1/1 100%	1/1 100%	28/34 82%	3/3 100%	56/69 81%
	L	5/10 60%	16/19 84%	1/1 100%	NONE	1/1 100%	NONE	1/1 100%	25/32 78%		
LEFT NEAR	R	1/6 17%	16/21 76%	3/3 100%	NONE	3/3 100%	NONE	2/3 67%	25/37 68%	17/19 89%	82/117 70%
	L	4/4 100%	3/10 30%	14/16 88%	NONE	5/16 56%	10/16 62%	NONE	40/61 66%		
AVERAGE RELIABILITY		77%	77%	89%	NONE	87%	88%	89%	81%	89%	82%

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to 100% with an average of 89%. There was no direct movement of the right or left hand, therefore the interobserver reliability data reported for that behavior descriptor was none. Indirect movement of the right or left hand produced contact with the stimulus object. The interobserver reliability data across stimulus positions for indirect movement ranged from 50% to 100% with an average of 87%. When there was movement of the right or left hand resulting in contact with the stimulus object and the testing surface, the interobserver reliability data across stimulus positions for on surface movement ranged from 60% to 100% with an average of 88%. When there was movement of the right or left hand resulting in contact with the stimulus object away from the testing surface, the interobserver reliability data across stimulus positions for off surface movement ranged from 67% to 100% with an average of 89%. The interobserver reliability data across stimulus positions for the right and left hands taken separately range from 66% to 98% with an average of 81%. The interobserver reliability data across stimulus positions for the right and left hand combined for all time intervals ranged from 76% to 100% with an average of 89%. The interobserver reliability data for the right and left hands combined across all stimulus positions, all behavior descriptors and all time intervals ranged from 70% to 94% with an overall average of 82%

Subject 2 (Amber). Table 2 presents the interobserver reliability data for the measurement of reach for Subject 2 in the sitting position. When there was no movement of the right or left hand, the interobserver reliability data across stimulus positions ranged from 62% to 100% with an average of 81%. When there was movement of the right or left hand resulting in no contact with the stimulus object, the interobserver reliability data across stimulus positions ranged from 50% to 100% with

TABLE 2

Reliability Scores for Subject 2 in a Sitting Position

STIMULUS POSITION	HAND	NO MOVEMENT	NO CONTACT	CONTACT	DIRECT	INDIRECT	ON SURFACE	OFF SURFACE	R/L	TIME	TOTAL
RIGHT FAR	R	15/15 100%	NONE	14/15 93%	12/15 80%	NONE	NONE	13/15 87%	54/60 90%	17/17 100%	99/112 88%
	L	21/27 78%	1/1 100%	2/2 100%	2/2 100%	NONE	NONE	2/2 100%	28/35 80%		
RIGHT NEAR	R	11/11 100%	NONE	19/19 100%	18/19 95%	NONE	NONE	19/19 100%	67/68 99%	15/20 75%	108/120 90%
	L	23/29 79%	NONE	1/1 100%	1/1 100%	NONE	NONE	1/1 100%	26/32 81%		
MID FAR	R	14/16 88%	2/2 100%	12/12 100%	9/12 75%	NONE	NONE	11/12 92%	48/54 89%	15/18 83%	98/114 86%
	L	16/22 73%	2/2 100%	6/6 100%	5/6 83%	NONE	NONE	6/6 100%	35/42 83%		
MID NEAR	R	13/15 87%	NONE	13/15 87%	13/15 87%	NONE	NONE	12/15 80%	51/60 85%	20/23 87%	109/129 84%
	L	13/21 62%	1/1 100%	8/8 100%	8/8 100%	NONE	NONE	8/8 100%	38/46 83%		
LEFT FAR	R	16/22 73%	2/2 100%	6/6 100%	6/6 100%	NONE	NONE	6/6 100%	36/42 86%	11/13 85%	83/99 84%
	L	17/21 81%	1/2 50%	6/7 86%	6/7 86%	NONE	NONE	6/7 86%	36/44 82%		
LEFT NEAR	R	15/19 79%	1/1 100%	10/10 100%	9/10 90%	NONE	NONE	10/10 100%	45/50 90%	24/25 96%	117/135 87%
	L	11/15 73%	NONE	12/15 80%	11/15 73%	NONE	NONE	12/15 80%	46/60 77%		
AVERAGE RELIABILITY		81%	93%	96%	89%	NONE	NONE	94%	85%	88%	87%

FM(R)10

an average of 93%. Where there was movement of the right or left hand that produced contact with the stimulus object, the interobserver reliability data across stimulus positions ranged from 80% to 100% with an average of 96%. Direct movement of the right or left hand produced contact with the stimulus object. The interobserver reliability data across stimulus positions for direct movement ranged from 73% to 100% with an average of 89%. There was no indirect movement of the right or left hand, therefore the interobserver reliability data reported for that behavior descriptor was none. There was no on surface movement producing contact with the stimulus object and the testing surface, therefore the interobserver reliability data reported for that behavior descriptor was none. There was off surface movement of the right and left hand resulting in contact with the stimulus object away from the testing surface. The interobserver reliability data across stimulus positions for off surface contact ranged from 80% to 100% with an average of 94%. The interobserver reliability separately ranged from 77% to 99% with an average of 85%. The interobserver reliability data across stimulus positions for the right and left hands combined for all time intervals ranged from 75% to 100% with an average of 88%. The interobserver reliability data for the right and left hands combined across all stimulus positions, all behavior descriptors and all time intervals ranged from 84% to 90% with an overall average of 87%

Subject 3 (Jennifer). Table 3 presents the interobserver reliability data for the measurement of reach for Subject 3 in the sitting position. When there was no movement of the right or left hand, the interobserver reliability across stimulus positions ranged from 43% to 100% with an average of 75%. When there was movement of the right or left hand resulting in no contact with the stimulus object, the interobserver reliability data

across stimulus positions ranged from 0% to 100% with an average of 73% and a middle score of 83%. When there was movement of the right or left hand that produced contact with the stimulus object, the interobserver reliability data across stimulus positions ranged from 56% to 100% with an average of 88%. When there was direct movement of the right or left hand that produced contact with the stimulus object, the interobserver reliability data across stimulus positions ranged from 0% to 100% with an average of 62%. When there was indirect movement of the right or left hand that produced contact with the stimulus object, the interobserver reliability across stimulus positions ranged from 67% to 100% with an average of 88%. When there was movement of the right or left hand resulting in contact with the stimulus object and the testing surface, the interobserver reliability data across stimulus positions for on surface contact ranged from 0% to 100% with an average of 48%. When there was movement of the right or left hand resulting in contact with the stimulus object away from the testing surface, the interobserver reliability data across stimulus positions for off surface contact ranged from 0% to 96% with an average of 73%. The interobserver reliability data across stimulus positions for the right and left hands taken separately ranged from 73% to 91% with an average of 82%. The interobserver reliability data across stimulus positions for the right and left hands combined for all time intervals ranged from 86% to 96% with an average of 92%. The interobserver reliability data for the right and left hands combined across all stimulus positions, all behavior descriptors and all time intervals ranged from 82% to 87% with an overall average of 85%.

Subject 4 (Loren). Table 4 presents the interobserver reliability data for the measurement of reach for Subject 4 in the sitting position.

TABLE 4

Reliability Scores for Subject 4 in a Sitting Position

STIMULUS POSITION	HAND	NO MOVEMENT	NO CONTACT	CONTACT	DIRECT	INDIRECT	ON SURFACE	OFF SURFACE	R/L	TIME	TOTAL
RIGHT FAR	R	NONE	NONE	30/30 100%	27/30 90%	NONE	NONE	27/30 90%	84/90 93%	30/30 100%	138/150 92%
	L	24/30 80%	NONE	NONE	NONE	NONE	NONE	NONE	24/30 80%		
RIGHT NEAR	R	NONE	NONE	30/30 100%	27/30 90%	NONE	NONE	27/30 90%	84/90 93%	30/30 100%	138/150 92%
	L	24/30 80%	NONE	NONE	NONE	NONE	NONE	NONE	24/30 80%		
MID FAR	R	NONE	NONE	30/30 100%	27/30 90%	NONE	NONE	27/30 90%	84/90 93%	26/30 87%	134/150 89%
	L	24/30 80%	NONE	NONE	NONE	NONE	NONE	NONE	24/30 80%		
MID NEAR	R	1/1 100%	2/2 100%	27/27 100%	24/27 89%	NONE	NONE	24/27 89%	78/84 93%	27/30 90%	140/150 93%
	L	23/24 96%	3/3 100%	3/3 100%	3/3 100%	NONE	NONE	3/3 100%	35/36 97%		
LEFT FAR	R	12/16 75%	5/6 83%	8/8 100%	7/8 88%	NONE	NONE	7/8 88%	39/46 85%	28/30 93%	130/150 87%
	L	8/8 100%	NONE	19/22 86%	19/22 86%	NONE	NONE	17/22 77%	63/74 85%		
LEFT NEAR	R	10/13 77%	6/6 100%	11/11 100%	10/11 91%	NONE	NONE	10/11 91%	47/52 90%	28/30 93%	139/150 93%
	L	9/11 82%	NONE	19/19 100%	19/19 100%	NONE	NONE	17/19 89%	64/68 94%		
AVERAGE RELIABILITY		86%	96%	98%	92%	NONE	NONE	89%	89%	94%	91%

FM(R)14

When there was no movement of the right or left hand, the interobserver reliability data across stimulus positions ranged from 75% to 100% with an average of 86%. When there was movement of the right or left hand resulting in no contact with the stimulus object, the interobserver reliability data across stimulus positions ranged from 83% to 100% with an average of 96%. When there was movement of the right or left hand that produced contact with the stimulus object, the interobserver reliability data across stimulus positions ranged from 86% to 100% with an average of 98%. Direct movement of the right or left hand produced contact with the stimulus object. The interobserver reliability data across stimulus positions for direct movement ranged from 86% to 100% with an average of 92%. There was no indirect movement of the right or left hand, therefore the interobserver reliability data reported for this behavior descriptor was none. When there was movement of the right and left hand resulting in contact with the stimulus object away from the testing surface, the interobserver reliability data across stimulus positions for off surface movement ranged from 77% to 100% with an average of 89%. The interobserver reliability data across stimulus positions for the right and left hands taken separately ranged from 80% to 97% with an average of 89%. The interobserver reliability data across stimulus positions for the right and left hand combined for all time intervals ranged from 87% to 100% with an average of 94%. The interobserver reliability data for the right and left hands combined across all stimulus positions, all behavior descriptors and all time intervals ranged from 87% to 93% with an overall average of 91%.

Overall Interobserver Reliability. A summary of interobserver reliability data for measurement of reach in the sitting position for

all subjects is presented in Table 5. When there was no movement of the right or left hand, the interobserver reliability across stimulus positions for all subjects ranged from 69% to 87% with an average of 79%. When there was movement of the right or left hand resulting in no contact with the stimulus object, the interobserver reliability data across stimulus positions for all subjects ranged from 30% to 94% with an average of 81%. When there was movement of the right or left hand that produced contact with the stimulus object, the interobserver reliability data across stimulus positions for all subjects ranged from 69% to 100% with an average of 95%. When there was direct movement of the right or left hand producing contact with the stimulus object, the interobserver reliability data across stimulus positions for all subjects ranged from 55% to 100% with an average of 87%. When there was indirect movement of the right or left hand producing contact with the stimulus object, the interobserver reliability data across stimulus positions for all subjects ranged from 50% to 100% with an average of 89%. When there was no surface movement of the right or left hand producing contact with the stimulus object, the interobserver reliability data across stimulus positions for all subjects ranged from 0% to 100% with an average of 73%. When there was off surface movement of the right or left hand producing contact with the stimulus object, the interobserver reliability data across stimulus positions for all subjects ranged from 67% to 94% with an average of 87%. The interobserver reliability data across stimulus positions for the right and left hands taken separately ranged from 78% to 90% with an average of 86%. The interobserver reliability data across stimulus positions for the right and left hand combined for all time intervals ranged from 88% to 94% with an average of 91%. The interobserver reliability data for the

TABLE 3

Reliability Scores for Subject 3 in a Sitting Position

STIMULUS POSITION	HAND	NO MOVEMENT	NO CONTACT	CONTACT	DIRECT	INDIRECT	ON SURFACE	OFF SURFACE	R/L	TIME	TOTAL
RIGHT FAR	R	3/7 43%	2/3 67%	20/20 100%	2/2 100%	17/18 94%	1/5 20%	14/15 93%	59/70 84%	26/29 90%	120/147 82%
	L	5/9 56%	11/12 92%	5/9 56%	3/3 100%	6/6 100%	NONE	5/9 56%	35/48 73%		
RIGHT NEAR	R	9/13 69%	1/1 100%	16/16 100%	1/2 50%	13/14 93%	2/4 50%	9/12 75%	51/62 82%	25/29 86%	124/147 84%
	L	10/14 71%	3/3 100%	12/13 92%	1/1 100%	10/12 83%	NONE	12/13 92%	48/56 86%		
MID FAR	R	17/22 77%	4/5 80%	2/3 67%	NONE	2/3 67%	NONE	2/3 67%	27/36 75%	25/27 93%	123/141 87%
	L	3/4 75%	1/2 50%	24/24 100%	1/5 20%	19/19 100%	NONE	23/24 96%	71/78 91%		
MID NEAR	R	21/24 88%	3/3 100%	2/3 67%	NONE	2/3 67%	1/1 100%	0/2 0%	29/36 81%	27/28 96%	125/144 87%
	L	2/2 100%	1/3 33%	25/25 100%	0/3 0%	21/22 95%	2/2 100%	18/23 78%	69/80 86%		
LEFT FAR	R	18/24 75%	5/6 83%	NONE	NONE	NONE	NONE	NONE	23/30 77%	22/23 96%	111/129 86%
	L	3/4 75%	0/3 0%	23/23 100%	NONE	21/23 91%	0/2 0%	19/21 90%	66/76 87%		
LEFT NEAR	R	18/26 69%	4/4 100%	NONE	NONE	NONE	NONE	NONE	22/30 73%	26/29 90%	125/147 85%
	L	1/1 100%	NONE	29/29 100%	NONE	26/29 90%	1/5 20%	20/24 83%	77/88 88%		
AVERAGE RELIABILITY		75%	73%	88%	62%	88%	48%	73%	82%	92%	85%

FM(R)12

TABLE 5

Overall Reliability Scores for All Subjects in a Sitting Position

STIMULUS POSITION	HAND	NO MOVEMENT	NO CONTACT	CONTACT	DIRECT	INDIRECT	ON SURFACE	OFF SURFACE	R/L	TIME	TOTAL
RIGHT FAR	R	23/28 82%	14/17 82%	74/75 99%	41/47 87%	27/28 96%	6/10 60%	58/65 89%	243/270 90%	83/88 94%	441/505 87%
	L	57/77 74%	27/31 87%	9/13 69%	5/5 100%	8/8 100%	1/1 100%	8/12 67%	115/147 78%		
RIGHT NEAR	R	27/33 82%	10/11 91%	74/76 97%	46/51 90%	22/25 88%	5/8 63%	60/68 88%	244/272 90%	81/91 89%	451/513 88%
	L	70/86 81%	15/19 79%	14/15 93%	2/2 100%	11/13 85%	NONE NONE	14/15 93%	126/150 84%		
MID FAR	R	40/48 83%	18/22 82%	49/50 98%	36/42 86%	7/8 88%	3/3 100%	42/47 89%	195/220 89%	76/86 88%	442/498 89%
	L	54/67 81%	16/17 94%	36/36 100%	6/11 55%	25/25 100%	3/3 100%	31/33 94%	171/192 89%		
MID NEAR	R	45/52 87%	15/18 83%	45/50 90%	37/42 88%	5/8 63%	4/6 67%	36/44 82%	187/220 85%	87/98 89%	461/534 86%
	L	16/57 81%	9/15 60%	47/48 98%	11/14 79%	32/34 94%	9/10 90%	33/38 87%	187/216 87%		
LEFT FAR	R	50/69 72%	32/35 91%	15/16 94%	13/14 93%	1/2 50%	1/1 100%	14/15 93%	126/152 83%	64/69 93%	380/447 85%
	L	34/43 79%	17/24 71%	49/53 92%	25/29 86%	22/24 92%	0/2 0%	43/51 84%	190/226 84%		
LEFT NEAR	R	44/64 69%	27/32 84%	24/24 100%	19/21 90%	3/3 100%	NONE NONE	22/24 92%	139/169 82%	95/103 92%	461/549 84%
	L	25/31 81%	3/10 30%	74/79 94%	30/34 88%	35/45 78%	11/21 52%	49/58 84%	227/277 82%		
AVERAGE RELIABILITY		79%	81%	95%	87%	89%	73%	87%	86%	91%	87%

FM(R)17

right and left hands combined across all stimulus positions, all behavior descriptors and all time intervals ranged from 84% to 89% with an overall average of 87%.

Performance Measures

The performance data for each subject are presented in Tables 6-9. The overall performance data for all four subjects combined are presented in Table 10.

In Tables 6-10 the first column labeled "Stimulus Position" indicates the position from which the stimulus object was presented to the subject. The second column labeled "Hand" indicates the movement/nonmovement of the right or left hand. The third through fifth columns labeled "No Movement," "No Contact," and "Contact" present the performance data as a percentage of the total number of trials performed across stimulus positions and right or left hand. The sixth through ninth columns labeled "Direct," "Indirect," "On Surface" and "Off Surface" present the performance data as a percentage of the total number of movement trials performed across stimulus positions and right or left hand. The tenth column labeled "Time" presents the performance data by time interval as a percentage of the total number of movement trials performed across stimulus positions and right or left hand. All performance data for Tables 6-9 are shown for 10 sessions with a total of 180 trials for the right hand and 180 trials for the left hand.

Subject 1 (Brian). Performance data are shown for 10 sessions. Data for the performance of reach in the sitting position for Subject 1 are presented in Table 6. Brian spent slightly more than one-quarter of his total movement trials without moving either his right or left

Table 6

Performance Data for Subject 1 in a Sitting Position

STIMULUS POSITION	HAND	NO MOVEMENT	NO CONTACT	CONTACT	DIRECT	INDIRECT	ON SURFACE	OFF SURFACE	TIME					
									0-3	3-6	6-9	9-12	12-15	over 15
RIGHT FAR	R	6 180	14 180	10 180	NONE	10 180	5 180	5 180	2 180		4 180	1 180		3 180
MID FAR	R	10 180	15 180	5 180	NONE	5 180	3 180	2 180		1 180		1 180		1 180
LEFT FAR	R	7 180	21 180	2 180	NONE	2 180	1 180	1 180						2 180
RIGHT NEAR	R	9 180	10 180	11 180	NONE	11 180	4 180	7 180	3 180	2 180		2 180	2 180	2 180
MID NEAR	R	12 180	13 180	5 180	NONE	5 180	5 180	NONE	1 180				2 180	2 180
LEFT NEAR	R	6 180	21 180	3 180	NONE	3 180	NONE	3 180	1 180					3 180
% OF TOTAL TRIALS	R	50 180 28%	94 180 52%	36 180 20%	NONE	36 180 20%	18 180 10%	18 180 10%	7 180 4%	3 180 2%	4 180 2%	4 180 2%	4 180 2%	14 180 8%
RIGHT FAR	L	10 180	18 180	2 180	NONE	2 180	1 180	1 180		1 180				1 180
MID FAR	L	11 180	13 180	6 180	NONE	6 180	3 180	3 180		1 180		1 180		4 180
LEFT FAR	L	10 180	19 180	1 180	NONE	1 180	NONE	1 180						1 180
RIGHT NEAR	L	13 180	16 180	1 180	NONE	1 180	NONE	1 180						1 180
MID NEAR	L	10 180	8 180	12 180	NONE	12 180	8 180	4 180	4 180	1 180		1 180	2 180	4 180
LEFT NEAR	L	4 180	10 180	16 180	NONE	16 180	16 180	NONE	8 180		1 180	2 180	180	5 180
% OF TOTAL TRIALS	L	58 180 32%	84 180 47%	38 180 21%	NONE	38 180 21%	28 180 16%	10 180 5%	12 180 7%	1 180 2%	1 180 1%	4 180 2%	2 180 1%	16 180 8%

hand. Nonmovement was equal for the right and left hand and occurred with equal frequency at both near and far distances. Nonmovement occurred less frequently in the left far and near stimulus positions than in the middle and right stimulus positions. Brian spent one-half of his total movement trials making random movements without contacting the stimulus object. Movement without contact occurred more frequently when the stimulus object was located in the far stimulus positions than in the near stimulus positions. Movement without contact was spread equally across the right and mid stimulus positions with most of the random movement occurring with the right hand in the left stimulus positions. Less than one-quarter of Brian's total movement trails were spent in actually contacting the stimulus object. Contacts were nearly equal for the right and left hand. Right hand contacts occurred most frequently at the near distance in the mid and left stimulus positions. Overall, stimulus objects placed in the mid stimulus position were contacted more frequently than objects placed in the left or right stimulus positions. Brian never contacted the stimulus object directly with either hand. All movement producing contact with the stimulus object were made indirectly. On surface contacts occurred more frequently than off surface contacts. On surface contacts occurred most frequently with the left hand at the near distances in the midline stimulus position. Off surface contacts occurred most frequently with the right hand at the near distances in the right stimulus position. Time interval data indicates that Brian contacted the stimulus object at the near distances usually within 0-15 seconds and at the far distances usually within 15 seconds to 2 minutes. Contacts in the 0-15 second time blocks occurred most frequently with the right hand in the right stimulus positions. Contacts in the 15 second to 2

minute time block occurred most frequently with the left hand in the mid stimulus position.

Subject 2 (Amber). Performance data are shown for 10 sessions. Data for the performance of reach in the sitting position for Subject 2 are presented in Table 7. Approximately two-thirds of Amber's total movement trials were spent in not moving her right or left hand when the stimulus object was presented to her. Left arm/hand nonmovement was considerably higher than right arm/hand nonmovement. Nonmovement occurred most frequently when the stimulus object was placed at the far distances and was spread fairly equally across all stimulus positions. Amber rarely engaged in movements which did not produce contact with the stimulus object. Nearly one-third of her total movement trials actually resulted in contact with the stimulus object. Amber made twice as many contacts with the right hand as with the left hand. Overall, contacts occurred most frequently at the near distances without much discernible preference for stimulus position. Right hand contacts were most frequently made at the near distance in the right stimulus position. Left hand contacts were most frequently made at the near distance in the left stimulus position. All contacts were direct in nature and were never made with the hand touching the testing surface while approaching the stimulus object. Most frequently it took Amber only 0-3 seconds to contact the stimulus object. Right hand contacts made after the 3 second time interval elapsed occurred most frequently when the stimulus object was placed in the right near stimulus position. Left hand contacts made after the 3 second time interval had elapsed occurred most frequently in the mid far stimulus position.

Subject 3 (Jennifer). Performance data are shown for 10 sessions. Data for the performance of reach in the sitting position for Subject 3 are presented in Table 8. Jennifer spent four-tenths of her total movement

TABLE 7

Performance Data for Subject 2 in a Sitting Position

STIMULUS POSITION	HAND	NO MOVEMENT	NO CONTACT	CONTACT	DIRECT	INDIRECT	ON SURFACE	OFF SURFACE	TIME						over 15
									0-3	3-6	6-9	9-12	12-15		
RIGHT FAR	R	15 180	NONE	15 180	15 180	NONE	NONE	15 180	11 180	2 180	2 180				
MID FAR	R	16 180	2 180	12 180	12 180	NONE	NONE	12 180	5 180	2 180	2 180	1 180		2 180	
LEFT FAR	R	22 180	2 180	6 180	6 180	NONE	NONE	6 180	4 180	2 180					
RIGHT NEAR	R	11 180	NONE	19 180	19 180	NONE	NONE	19 180	11 180	1 180	4 180			1 180	
MID NEAR	R	15 180	NONE	15 180	15 180	NONE	NONE	15 180	14 180				1 180		
LEFT NEAR	R	19 180	1 180	10 180	10 180	NONE	NONE	10 180	7 180	1 180	1 180			1 180	
% OF TOTAL TRIALS	R	98 180 54%	5 180 3%	77 180 43%	77 180 43%	NONE	NONE	77 180 43%	54 180 30%	8 180 4%	1 180 5%	1 180 1%	1 180 1%	4 180 2%	
RIGHT FAR	L	27 180	1 180	2 180	2 180	NONE	NONE	2 180	2 180						
MID FAR	L	22 180	2 180	6 180	6 180	NONE	NONE	6 180	3 180	2 180		1 180			
LEFT FAR	L	21 180	2 180	7 180	7 180	NONE	NONE	7 180	4 180	1 180	1 180		1 180		
RIGHT NEAR	L	29 180	NONE	1 180	1 180	NONE	NONE	1 180			1 180				
MID NEAR	L	21 180	1 180	8 180	8 180	NONE	NONE	8 180	6 180	2 180					
LEFT NEAR	L	15 180	NONE	15 180	15 180	NONE	NONE	15 180	12 180		2 180		1 180		
% OF TOTAL TRIALS	L	135 180 75%	6 180 3%	39 180 22%	39 180 22%	NONE	NONE	39 180 22%	27 180 15%	5 180 3%	4 180 2%	1 180 1%	1 180 1%		

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TABLE 8

Performance Data for Subject 3 in a Sitting Position

STIMULUS POSITION	HAND	NO MOVEMENT	NO CONTACT	CONTACT	DIRECT	INDIRECT	ON SURFACE	OFF SURFACE	TIME					
									0-1	3-6	6-9	9-12	12-15	over 15
RIGHT FAR	R	7 180	3 180	20 180	2 180	18 180	5 180	15 180	3 180	4 180	5 180	2 180	1 180	5 180
MID FAR	R	22 180	5 180	3 180	NONE 180	3 180	NONE 180	3 180		1 180		2 180		
LEFT FAR	R	24 180	6 180	NONE 180	NONE 180	NONE 180	NONE 180	NONE 180						
RIGHT NEAR	R	13 180	1 180	16 180	2 180	14 180	4 180	12 180	1 180	7 180	4 180	2 180		2 180
MID NEAR	R	24 180	3 180	3 180	NONE 180	3 180	1 180	2 180	2 180					
LEFT NEAR	R	26 180	4 180	NONE 180	NONE 180	NONE 180	NONE 180	NONE 180						
% OF TOTAL TRIALS	R	116 180 65%	22 180 12%	42 180 23%	4 180 2%	38 180 21%	10 180 5%	32 180 18%	6 180 3%	12 180 7%	10 180 6%	6 180 3%	1 180 1%	7 180 3%
RIGHT FAR	L	9 180	12 180	9 180	3 180	5 180	NONE 180	9 180	3 180	3 180	2 180			1 180
MID FAR	L	4 180	2 180	24 180	5 180	19 180	NONE 180	21 180	3 180	9 180	3 180	3 180	3 180	3 180
LEFT FAR	L	4 180	3 180	23 180	NONE 180	23 180	2 180	21 180	4 180	9 180	4 180	2 180	2 180	2 180
RIGHT NEAR	L	14 180	2 180	13 180	1 180	12 180	NONE 180	13 180	6 180	3 180	3 180	1 180		
MID NEAR	L	2 180	3 180	25 180	3 180	22 180	2 180	23 180	7 180	7 180	9 180	2 180		
LEFT NEAR	L	1 180	NONE 180	29 180	NONE 180	29 180	5 180	24 180	10 180	11 180	4 180	2 180	2 180	
% OF TOTAL TRIALS	L	34 180 19%	23 180 13%	123 180 68%	12 180 6%	111 180 62%	9 180 5%	114 180 63%	33 180 18%	42 180 23%	25 180 14%	10 180 6%	7 180 4%	6 180 3%

M(R)23

trials without moving her right or left hand. Nonmovement of the right hand occurred three times more frequently than nonmovement of the left hand. Nonmovement occurred most frequently when the stimulus object was located at the near distances. Jennifer's movement without contacting the stimulus object averaged only one-tenth of her total movement trials. Movement without contact was nearly equal for right and left hand. It occurred most frequently at the far distances or when the stimulus object was located in the right stimulus positions. Nearly one-half of Jennifer's total movement trials were spent in contacting the stimulus object. Contacts occurred three times more frequently with the left hand than the right hand. Right hand contacts occurred most frequently at the far distance in the right stimulus position. Left hand contacts occurred most frequently at the near distance in the left stimulus position. Jennifer made very few contacts directly. When she did contact the stimulus object directly, it was with her left hand at the far distance in the mid stimulus position. Indirect contacts occurred nine times more frequently than direct contacts and occurred three times more frequently with the left hand than the right hand. Most of the indirect contacts were made at the near distances and were spread fairly equally across all stimulus positions. Jennifer's hand seldom remained on the testing surface during contact with the stimulus object. On surface contacts were usually made with the left hand at the near distance when the stimulus object was in the right stimulus position. Off surface contacts were several times greater than on surface contacts. There were three times more off surface contacts with the left hand than the right hand. Off surface contacts occurred with nearly equal frequency at both near and far distances and

across all stimulus positions. One third of all contact responses were made within 0-3 seconds. Right hand contacts made after 3 seconds had elapsed occurred most frequently in the right far stimulus position. Left hand contacts made after 3 seconds had elapsed occurred most frequently in the mid far stimulus position.

Subject 4 (Loren). Performance data are shown for 10 sessions. Data for the performance of reach in the sitting position for Subject 4 are presented in Table 9. Loren spent over one-third of total movement trials in not moving his left hand. Nonmovement occurred most frequently when the stimulus object was located at the far distances or in the right stimulus positions. Loren had very few movement-no-contact responses. One-half of Loren's total movement trials were spent in contacting the stimulus object. Three-quarters of all contacts were made with his right hand and one-quarter were made with his left hand. Right-handed contacts were most likely to occur in the right and mid stimulus position. Left-handed contacts were most likely to occur in the left stimulus positions. All of Loren's contacts were direct and off surface. These contacts occurred with equal frequency across near and far distances and right, mid and left stimulus positions. Most frequently it took Loren only 0-3 seconds to contact the stimulus object. Right-hand contacts made after 3 seconds had elapsed occurred most frequently at the mid far stimulus position. Left hand contacts made after 3 seconds had elapsed occurred most frequently at the mid near stimulus position.

Discussion

Overall, the reach assessment proved to be reliable in observing reach behaviors of handicapped and nonhandicapped children. The lowest total average reliability across all descriptors and stimulus positions for both

TABLE 9

Performance Data for Subject 4 in a Sitting Position

STIMULUS POSITION	HAND	NO MOVEMENT	NO CONTACT	CONTACT	DIRECT	INDIRECT	ON SURFACE	OFF SURFACE	TIME					
									0-3	3-6	6-9	9-12	12-15	over 15
RIGHT FAR	R	NONE	NONE	30 180	30 180	NONE	NONE	30 180	28 180	2 180				
MID FAR	R	NONE	NONE	30 180	30 180	NONE	NONE	30 180	20 180	3 180	3 180	4 180		
LEFT FAR	R	16 180	6 180	8 180	8 180	NONE	NONE	8 180	8 180					
RIGHT HEAR	R	NONE	NONE	30 180	30 180	NONE	NONE	30 180	29 180			1 180		
MID HEAR	R	1 180	2 180	27 180	27 180	NONE	NONE	27 180	18 180	7 180	2 180			
LEFT HEAR	R	13 180	6 180	11 180	11 180	NONE	NONE	11 180	8 180			3 180		
% OF TOTAL TRIALS	R	30 180 17%	14 180 7%	136 180 76%	136 180 76%			136 180 76%	111 180 62%	12 180 7%	5 180 3%	8 180 4%		
RIGHT FAR	L	30 180	NONE	NONE	NONE	NONE	NONE	NONE						
MID FAR	L	30 180	NONE	NONE	NONE	NONE	NONE	NONE						
LEFT FAR	L	8 180	NONE	22 180	22 180	NONE	NONE	22 180	14 180	3 180	4 180		1 180	
RIGHT HEAR	L	30 180	NONE	NONE	NONE	NONE	NONE	NONE						
MID HEAR	L	24 180	3 180	3 180	3 180	NONE	NONE	3 180	2 180	1 180				
LEFT HEAR	L	11 180	NONE	19 180	19 180	NONE	NONE	19 180	10 180	4 180			2 180	3 180
% OF TOTAL TRIALS	L	133 180 74%	3 180 2%	44 180 24%	44 180 24%	NONE	NONE	44 180 24%	26 180 14%	8 180 4%	4 180 2%		3 180 2%	3 180 2%

FM(R)26

the right and left hands of all children tested with 84% while the highest was 89%. The individual behavior descriptor with the highest percentage of reliability across all stimulus positions and all children was the contact descriptor with reliability scores ranging from 88% to 98%. The behavior descriptor with the lowest percentage of reliability across all stimulus positions and all children was the on-surface descriptor with reliability scores ranging from 48% to 88% across only two children. The grand total reliability score across all behavior descriptors, stimulus positions, time intervals and subjects was 87% (Table 5). Types of reliability disagreements made were in the scoring of the no movement, no contact, direct, on surface, and off surface behavior descriptors.

One of the most frequent reliability disagreements made was the scoring of the no movement behavior descriptor. This may have been due to the difficulty of watching the subject's right and left hand at the same time. If the subject's right hand was moving in the direction of the stimulus object while the left hand was not moving, the eye of the examiner and the observer were on the right hand and not on the left hand. Scoring difficulty was increased if the subject's hand movement was sustained for longer than the initial 15 second time limit or if the right hand and left hand were not in close proximity to one another.

Another behavior descriptor which frequently received low reliability scores was the movement-no-contact descriptor. This descriptor was scored in two different types of situations, the first type being easier to score than the second type. In the first type of situation, the subject was moving only one hand. The examiner and the observer watched this hand movement to observe whether it would result in contact with the stimulus object or if it would stop for two seconds signaling the end of the trial.

In the second type of situation, the subject was moving both hands. One hand moved only slightly and it was difficult to judge whether there had been an obvious change in the angles of the elbow and/or shoulder joints by 15 degrees or more. In the meantime, the other hand had contacted the stimulus object and the examiner and the observer were noting the descriptive characteristics of the contact response such as directness, on or off surface and time. Also, it was sometimes difficult to determine whether it was the subject's right hand that had moved without contact and the left hand that had contacted the stimulus object or vice versa.

The third type of reliability disagreement involved the direct behavior descriptor. The direct descriptor was defined clearly enough. However, this descriptor could only be scored when the subject's movement resulted in contact with the stimulus object. In some cases, the frequency with which contact occurred was rather low. Therefore, the percent data figured for the direct descriptor misrepresented the stated average reliability of the descriptor because, in some cases, the total trials were often as low as one or two. This meant that if the examiner and the observer did not agree, reliability for the direct descriptor in that stimulus position was 0%. In one case, for one subject this happened in several stimulus positions which brought the average reliability across all stimulus positions down considerably.

The last type of reliability disagreement in behavior descriptors was a discrepancy between on-surface contacts and off-surface contacts. This discrepancy occurred with only one subject. In this situation, the on-surface and off-surface descriptors were clearly defined.

This measurement tool gave a large quantity of useful information about the arm and hand used most efficiently in reaching for each subject.

This examiner found that the arrangement of the stimulus positions, behavior descriptors and time intervals separated by hand on the performance tables proved to be a critical factor in the ease with which skill data were obtained for left hand and right hand performance (See Tables 6-9). All subjects tested showed a preference for one hand over the other. Subjects 1 and 3 (Handicapped) engaged in reaching activity with their left hand while Subject 2 (Handicapped) and Subject 4 (Nonhandicapped) engaged in reaching most often with their right hands. Differences between near and far reaching responses for each subject were easy to observe accurately. For example, as a result of using this assessment tool, it became apparent that Subjects 1, 2, and 3 (Handicapped) preferred reaching for stimulus objects in the near stimulus positions. This could have been due to several factors such as limited range of motion of one or both hands, unattractiveness of stimulus objects placed in the far stimulus positions, the activity level and compliance level of the subject during assessment in the far positions and the sequence of presentation of stimulus objects. Subject 4 (Nonhandicapped) reached for all objects placed at both near and far stimulus positions with equal frequency. The angles of the reaching response were clearly identified and readily observable. For example, the assessment data showed that Subjects 1 and 2 (Handicapped) preferred to reach for stimulus objects when they were placed at the mid angle whereas Subject 3 (Handicapped) preferred to reach for objects at the right angle while Subject 4 (Nonhandicapped) showed no preference but reached for all objects regardless of angle. This assessment tool appeared to reflect correctly the reaching skill level at each distance from an angle to the child's midline. From this assessment procedure, the examiner has been able to

determine the most functional stimulus position(s) for eliciting the reach response from all subjects tested. For example, the best position for Subject 1 (Handicapped) was the right far position, for Subject 2 (Handicapped) the left near position, for Subject 3 (Handicapped) the right far, right near and left near positions and for Subject 4 (Nonhandicapped) all positions.

The number of direct, off-surface reach responses increased across time for Subject 2 (Handicapped) and Subject 4 (Nonhandicapped). The data indicates that this assessment device is sensitive to both the emerging reach skills as in the case of Subject 2 (Handicapped) and the more mature reach skills displayed by Subject 4 (Nonhandicapped). This device also screened out the subject with no reach skills, Subject 1 (Handicapped); and the subject with immature reach skills, Subject 3 (Handicapped).

Several recommendations for further research can be made. First, the assessment procedures should be expanded to include three testing levels: elbow level, chest level and shoulder level for subjects using the sitting body position. Raising the level of the testing surface would allow subjects with poor vision to see the stimulus object more clearly because it is brought closer to their eyes. This examiner noticed that Subject 1 (Handicapped) held his hands up and close to his shoulders and head. He rarely extended his arms/hands below chest level which may have been the reason why his reaching contacts fell below the 25% level. He also appeared to have poor vision. Raising the level of the testing surface would have brought the stimulus object closer to his eyes with the possible result of increasing the number of reach contacts made by the subject. Second, sustained reach might be another indicator

of mature reach skills. Sustained reach occurs in the natural environment when a child plays with a toy typewriter or piano by reaching for the keys and placing his/her fingertips upon them to produce action or sound. Other examples include reaching for food with eating utensils or rinsing a toothbrush under running water. A sustained reach behavior descriptor could be added to the assessment procedures and observed in both structured and unstructured settings. The time interval section could be expanded to include a column for sustained reach duration data by structured or unstructured setting.

A REPLICATION STUDY:
Quantitative Assessment of Grasp Among
Severely Handicapped and Nonhandicapped Infants and Children¹

by
Cherie Mears
and
Dave Esquith

¹The procedures and data reported in this study were taken from a Master's thesis by Cherie Mears that was submitted to the Department of Special Education, University of Kansas, in January, 1981.

Overview of Measurement Procedures

A complete description of the measurement procedures used in this study is found in pages FM(G)1 to FM(G)21 of Volume I, Assessment Procedures for Selected Developmental Milestones. Procedures were developed to measure voluntary grasp in the sitting, standing, and sidelying positions. The hand was divided into seven distinct areas to provide an objective method of coding and recording grasp responses across four stimulus objects. The descriptors observed across the stimulus objects included digit use, palm/tip frequency, right/left hand use, and no grasp trials. The four stimulus objects were presented three times per hand for a total of 24 trials per session. The stimulus objects were preferred items from the child's environment in cylindrical, spherical, cube, and pellet shapes.

Grasp was measured by an occurrence recording of the use of the parts of the hand and fingers involved in the grasp response. The child was placed in the desired position with forearms resting on the presentation surface. After the child's hand had contacted the surface for at least 2 seconds, the examiner gained the child's attention and placed the stimulus object within 1 to 2 inches (2.5 cm to 5 cm) of the thumb side (radical side) of the child's hand. The child had 10 seconds to grasp the object and completely remove it from the presentation surface. If the child failed to respond to the initial cues, the examiner was free to physically prompt or verbally cue the child during the 10 second interval. The examiner was also free to stabilize the object. If the child pushed the object off the presentation surface or out of reach the trial was discounted and repeated. The child was considered to be engaged in the grasping response the moment the object was secured in one hand and no longer supported by any other surface.

Subjects

The subjects selected for this study consisted of three severely multiply handicapped children and one nonhandicapped infant. The handicapped children were enrolled in a university preschool. They were chosen because of the presence of manipulative skills at appropriate levels of functioning. The normally developing infant was a relative of the examiner.

Subject 1. Dan was a normally developing infant observed during his eighth through tenth month of age. He could stand at a table while supporting himself with one hand.

Subject 2. Janice was a five year old with spastic quadriplegia with a possible hearing loss. She placed at about the 10 month level for fine motor skills.

Subject 3. Jack was a four year old exhibiting 11 of Rindler-Schjerve's characteristics of autism. He placed at about the 12 month level for five motor skills.

Subject 4. Scott was a two year old with cerebral palsy and spastic quadriplegia. He placed at the 10 month level for fine motor skills.

Procedures for Obtaining Measures of Reliability

Reliability measures were taken at each data recording session. The reliability observers participating in the study were mothers of children involved in the research and a parent consultant on the staff of the severely multiply handicapped preschool. Each observer was trained by the examiner following a revised form of the Procedures of Measurement. Two measures of reliability were computed: 1) column or descriptor reliability per Digit, Palm/Tip, and Selected hand, and 2) row or descriptor reliability across stimulus objects.

The degree of reliability was determined by using the following formula:

$$\frac{\# \text{ of agreements}}{\# \text{ of agreements} + \# \text{ of disagreements}}$$

For each trial, the total number of agreements was established by comparing the data for each examiner under the descriptor columns and rows. The number of agreements was added to the number of disagreements to represent the total number possible. The percent of reliability was derived by dividing the number of agreements by the number of agreements plus the number of disagreements and multiplied by 100.

Results

Measures of Interobserver Reliability

The interobserver reliability data for each subject are presented in Tables 1-9. Tables 1-8 present interobserver reliability data for individual subject behaviors. Table 9 presents overall mean reliability scores by subject and position. Tables 1, 3, 5 and 7 present interobserver reliability percentage scores for digit use across all other variables by subject. Tables 2, 4, 6 and 8 present interobserver reliability percentage scores for all objects and descriptors across all other variables by subject.

Subject 1 (Dan). Interobserver reliability for digit use across four stimulus objects ranged from 81%-100% with a mean reliability of 95% (see Table 1). The lowest digit use interobserver reliability was 92% with digit 5. The highest digit use reliability was 98% with both digits 1 and 2. Mean interobserver reliability for digit use with the individual hand ranged from 90%-100% with the right hand and 96%-98% with the left hand.

Table 1

Interobserver Reliability Scores for
Digit Use Across All Other Variables
For Subject 1 Based on 10 Sessions

Digit	Hand	Mean Reliability Individual Hand	Mean Reliability Total Behavior
1	Right	100	98
	Left	96	
2	Right	98	98
	Left	98	
3	Right	93	95
	Left	96	
4	Right	97	96
	Left	96	
5	Right	90	92
	Left	95	
			<u>Grand Mean Reliability</u>
			95

Table 2

Interobserver Reliability Scores For
Descriptors Across All Other Variables
For Subject 1 Based on 10 Sessions

Object/ Descriptor	Hand	Mean Reliability Individual Hand	Mean Reliability Total Behavior
Cylinder	Right	98	97
	Left	96	
Ball	Right	95	96
	Left	97	
Block	Right	97	97
	Left	98	
Pellet	Right	94	94
	Left	94	
Tip	Right	92	93
	Left	94	
Selected	Right	95	97
	Left	99	
No Grasp	Right	100	100
	Left	100	
			Grand Mean Reliability
			97

Table 3

Interobserver Reliability Scores For
Digit Use Across All Other Variables
For Subject 2 Based on 10 Sessions

Digit	Hand	Mean Reliability Individual Hand	Mean Reliability Total Behavior
1	Right	97	97
	Left	-	
2	Right	98	98
	Left	-	
3	Right	98	98
	Left	-	
4	Right	96	96
	Left	-	
5	Right	95	95
	Left	-	
			<u>Grand Mean Reliability</u>
			96

Table 4

Interobserver Reliability Scores For
Descriptors Across All Other Variables
For Subject 2 Based On 10 Sessions

Object/ Descriptor	Hand	Mean Reliability Individual Hand	Mean Reliability Total Behavior
Cylinder	Right	98	98
	Left	-	
Ball	Right	98	98
	Left	-	
Block	Right	97	97
	Left	-	
Pellet	Right	93	93
	Left	-	
Tip	Right	97	97
	Left	-	
Selected	Right	96	100
	Left	-	
No Grasp	Right	100	100
	Left	-	
			<u>Grand Mean Reliability</u>
			97

Table 5

Interobserver Reliability Scores For
Digit Use Across All Other Variables
For Subject 3 Based on 10 Sessions

Digit	Hand	Mean Reliability Individual Hand	Mean Reliability Total Behavior
1	Right	99	99
	Left	100	
2	Right	100	100
	Left	100	
3	Right	94	95
	Left	97	
4	Right	97	95
	Left	93	
5	Right	93	93
	Left	94	
			Grand Mean Reliability
			96

Table 6

Interobserver Reliability Scores For
Descriptors Across All Other Variables
For Subject 3 Based on 10 Sessions

Object/ Descriptor	Hand	Mean Reliability Individual Hand	Mean Reliability Total Behavior
Cylinder	Right	95	95
	Left	95	
Ball	Right	96	97
	Left	97	
Block	Right	95	95
	Left	95	
Pellet	Right	100	100
	Left	100	
Tip	Right	96	97
	Left	99	
Selected	Right	96	97
	Left	99	
No Grasp	Right	100	100
	Left	100	
			<u>Grand Mean Reliability</u>
			97

Table 7

Interobserver Reliability Scores For
Digit Use Across All Other Variables
For Subject 4 Based on 9 Sessions

Digit	Hand	Mean Reliability Individual Hand	Mean Reliability Total Behavior
1	Right	95	97
	Left	99	
2	Right	84	91
	Left	98	
3	Right	97	98
	Left	100	
4	Right	98	98
	Left	98	
5	Right	96	96
	Left	96	
			Grand Mean Reliability
			96

Table 8

Interobserver Reliability Scores For
Descriptors Across All Other Variables
For Subject 4 Based on 9 Sessions

Object/ Descriptor	Hand	Mean Reliability Individual Hand	Mean Reliability Total Behavior
Cylinder	Right	95	97
	Left	100	
Ball	Right	100	99
	Left	98	
Block	Right	95	97
	Left	98	
Pellet	Right	95	97
	Left	97	
Tip	Right	97	98
	Left	100	
Selected	Right	96	94
	Left	93	
No Grasp	Right	100	100
	Left	100	
			Grand mean Reliability
			97

Table 9

Grand Mean Interobserver Reliability
Scores by Subject and Position
Based On All Sessions

Subject	Sitting	Position Standing	Sidelying
1		96	
2		93	
3	97		
4			95
			Grand Mean Reliability Across 4 Subjects in 3 Positions
			95

Interobserver reliability for digit descriptors across the four stimulus objects ranged from 93%-100% with a mean reliability of 97% (see Table 2). Interobserver reliability for Palm/Tip descriptors across four stimulus objects ranged from 74%-100% with a mean reliability of 93%. Interobserver reliability for selected grasp across four stimulus objects ranged from 91%-100% with a mean reliability of 97%. Mean interobserver reliability for No Grasp across four stimulus objects was 100%.

Interobserver reliability for digit, Palm/Tip and selected descriptors across sessions with the cylinder ranged from 89%-100% with a mean reliability of 97%. Interobserver reliability for the ball ranged from 90%-100% with a mean reliability of 96%. Interobserver reliability for the block ranged from 93%-100% with a mean reliability of 97%. Interobserver reliability for the pellet ranged from 83%-100% with a mean reliability of 94%.

Interobserver reliability for all descriptors across the right hand ranged from 92%-100% with a mean reliability of 95%. Interobserver reliability for all descriptors across the left hand ranged from 94%-100% with a mean reliability of 96%. Interobserver reliability for stimulus across the right hand ranged from 94%-98% with a mean reliability of 98%. Interobserver reliability for stimulus objects across the left hand ranged from 94%-98% with a mean reliability of 96%.

Subject 2 (Janice). Table 3 represents reliability scores for Subject 2. These data reflect reliability for the right hand only, as Janice did not grasp any stimulus objects with the left hand.

Interobserver reliability for digit use across the four stimulus objects ranged from 71%-100% with a mean reliability of 96%. The lowest

digit use interobserver reliability was 95% with digit 5. The highest digit use interobserver reliability was 98% with digits 2 and 3.

Interobserver reliability for digit descriptors across the four stimulus objects ranged from 95%-98% with a mean reliability of 96% (see Table 4). Interobserver reliability for Palm/Tip descriptors across four stimulus objects ranged from 85%-100% with a mean reliability of 97%. Mean interobserver reliability for selected grasp across four stimulus objects was 100%. Mean interobserver reliability for No Grasp across four stimulus objects was 100%.

Interobserver reliability for digit, Palm/Tip and selected descriptors across sessions with the cylinder ranged from 93%-100% with a mean reliability of 98%. Interobserver reliability for the ball ranged from 93%-100% with a mean reliability of 98%. Interobserver reliability for the block ranged from 80%-100% with a mean reliability of 97%. Interobserver reliability for the pellet ranged from 80%-100% with a mean reliability of 93%.

All data were obtained for the right hand. Interobserver reliability for the right hand across all descriptors ranged from 95%-100% with a mean reliability of 97%. Interobserver reliability for all stimulus objects ranged from 93%-98% with a mean reliability of 96%.

Subject 3 (Jack). Interobserver reliability for digit use across four stimulus objects ranged from 75%-100% with a mean reliability of 96% (see Table 5). The lowest digit use interobserver reliability was 93% with digit 5. The highest digit use interobserver reliability was 100% with digit 2. Mean interobserver reliability for digit use with the individual hand ranged from 93%-100% with either hand.

Interobserver reliability for digit descriptors across the four stimulus objects ranged from 93%-100% with a mean reliability of 96% (see Table 6). Interobserver reliability for Palm/Tip descriptors across four stimulus objects ranged from 85%-100% with a mean reliability of 96%. Interobserver reliability for selected grasp across four stimulus objects ranged from 95%-100% with a mean reliability of 99%. The mean reliability for No Grasp was 100%.

Interobserver reliability for digit, Palm/Tip and selected descriptors across sessions with the cylinder ranged from 90%-100% with a mean reliability of 95%. Interobserver reliability for the ball ranged from 90%-100% with a mean reliability of 97%. Interobserver reliability for the block ranged from 88%-100% with a mean reliability of 95%. Mean reliability with the pellet was 100%.

Interobserver reliability for all descriptors across the right hand ranged from 93%-100% with a mean reliability of 96%. Interobserver reliability for all descriptors across the left hand ranged from 93%-100% with a mean reliability of 97%. Interobserver reliability for stimulus objects across the right hand ranged from 95%-100% with a mean reliability of 96%. Interobserver reliability for stimulus objects across the left hand ranged from 95%-100% with a mean reliability of 96%.

Subject 4 (Scott). Interobserver reliability for digit use across the four stimulus objects ranged from 85%-100% with a mean reliability of 96% (see Table 7). The lowest digit use interobserver reliability was 91% with digit 2. The highest digit use interobserver reliability was 98% with digits 3 and 4. Mean interobserver reliability for digit use with the individual hand ranged from 84%-98% with the right hand and 96%-100% with the left hand.

Interobserver reliability for digit descriptors across the four stimulus objects ranged from 96%-100% with a mean reliability of 97% (see Table 8). Interobserver reliability for Palm/Tip descriptors across four stimulus objects ranged from 95%-100% with a mean reliability of 98%. Interobserver reliability for selected grasp across four stimulus objects ranged from 73%-100% with a mean reliability of 94%. Mean reliability for No Grasp was 100%.

Interobserver reliability for digit, Palm/Tip and selected descriptors across sessions with the cylinder ranged from 85%-100% with a mean reliability of 97%. Interobserver reliability for the ball ranged from 95%-100% with a mean reliability of 99%. Interobserver reliability for the block ranged from 90%-100% with a mean reliability of 97%. Interobserver reliability for the pellet ranged from 93%-100% with a mean reliability of 97%.

Interobserver reliability for all descriptors across the right hand ranged from 84%-100% with a mean reliability of 95%. Interobserver reliability for all descriptors across the left hand ranged from 93%-100% with a mean reliability of 98%. Interobserver reliability for stimulus objects across the right hand ranged from 95%-100% with a mean reliability of 97%. Interobserver reliability for all stimulus objects across the left hand ranged from 97%-100% with a mean reliability of 98%.

Overall interobserver reliability. Interobserver reliability for Subject 1 ranged from 93%-100% with a mean reliability of 96%. Interobserver reliability for Subject 2 ranged from 93%-100% with a mean reliability of 93%. Interobserver reliability for Subject 3 ranged from 95%-100% with a mean reliability of 97%. Interobserver reliability ranged from 84%-100% for Subject 4 with a mean reliability of 95%. Data

obtained from Subjects 1 and 2 yielded a mean reliability score of 94% for the standing position. Mean reliability in the sitting position is 97%. Mean reliability in the sidelying position is 95%.

Performance Measures

The performance data for each subject are contained on the graphs in Figures 1-8. Each figure contains 16 graphs, one for each behavior descriptor. The numbers on the abscissa of each graph represent the sessions. The ordinate of each graph represents 0-3 frequency performance of a given descriptor. The symbols and connecting lines are labeled at the bottom of each figure. Figures 1 and 2 present the performance of Subject 1 as a frequency of all responses by stimulus object for each session. Figures 3 and 4 present the performance of Subject 2 as a frequency of all responses by stimulus object for each session. Figures 5 and 6 present the performance of Subject 3 as a frequency of all responses by stimulus object for each session. Figures 7 and 8 present the performance of Subject 4 as a frequency of all responses by stimulus object for each session.

Subject 1 (Dan). Performance data are shown for 10 sessions. Data for responses across all descriptors with the cylinder and ball stimulus objects are represented in Figure 1. This figure illustrates an overall increasing trend in radial digit use with both stimulus objects. The left hand clearly showed this trend with the ball. Greater fluctuation in radial digit use is noted with the right hand for both objects. Tip use is fairly constant for both hands with the ball and for the left hand with the cylinder. Right hand tip frequency with the cylinder fluctuates across sessions. The right hand is selected with greater frequency than the left hand in the first six sessions. No Grasp re-

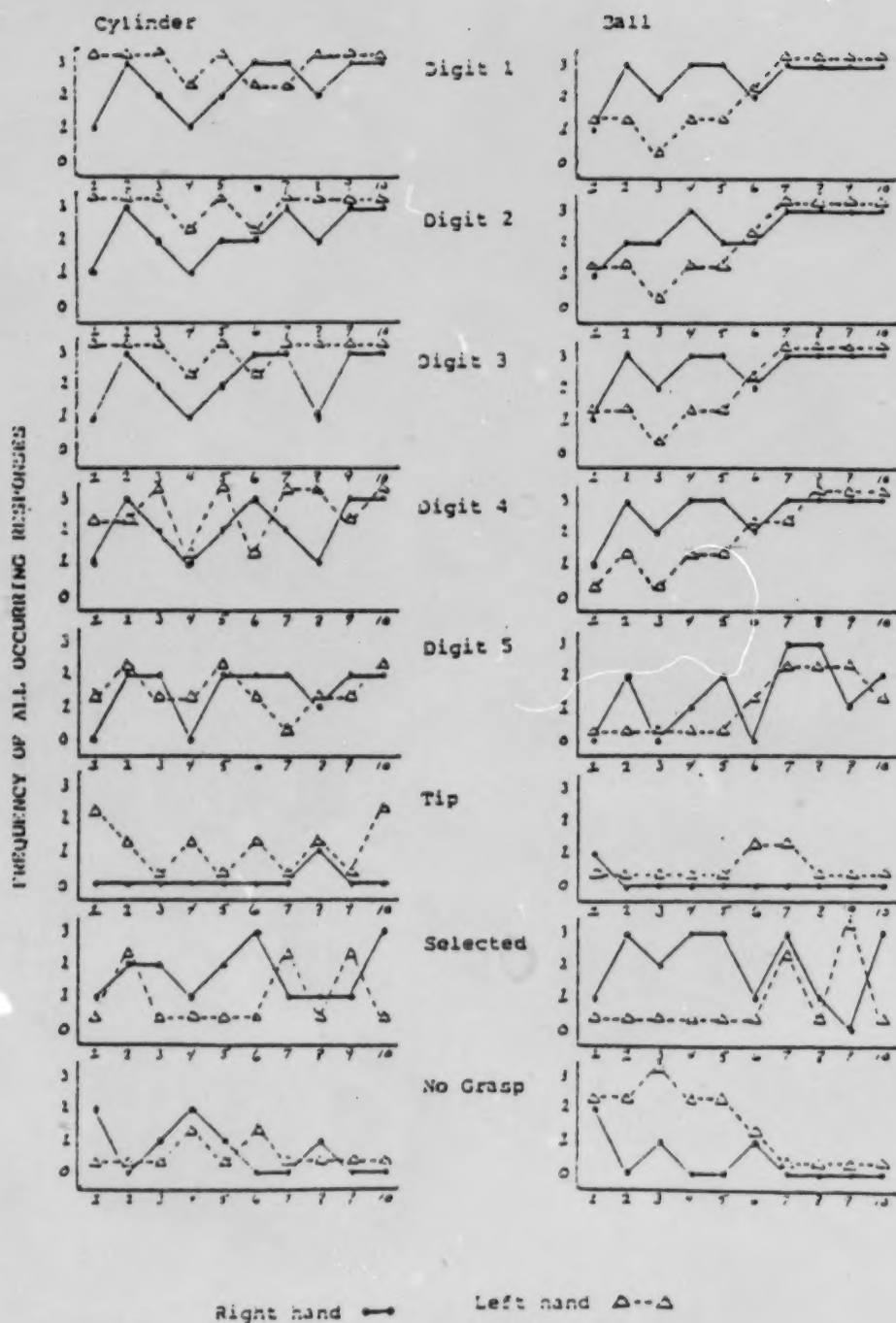


Figure 1. Frequency of behavior responses across cylinder and ball for Subject 1 (Dan)

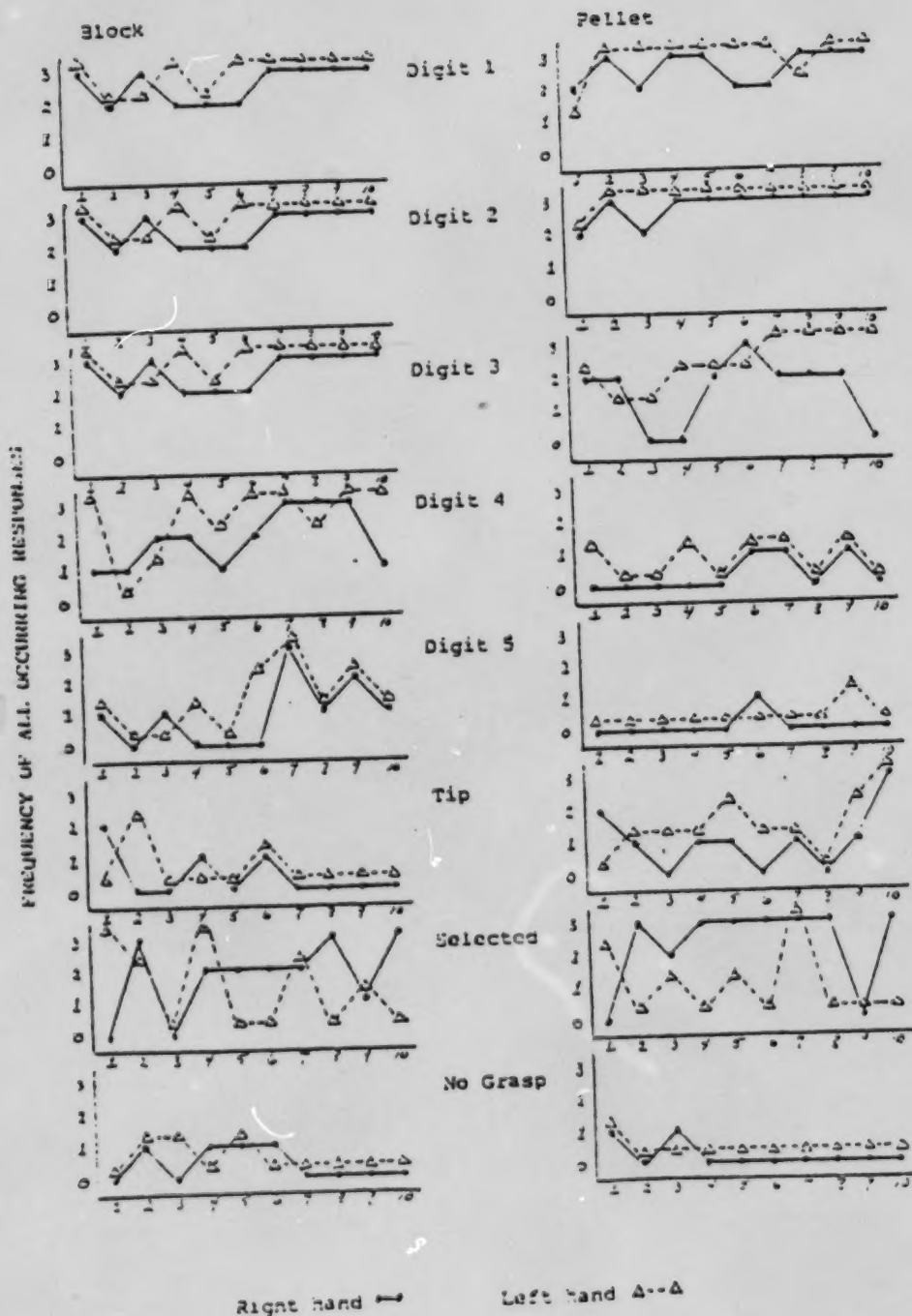


Figure 2. Frequency of behavior responses across block and pellet for Subject 1 (Dan)

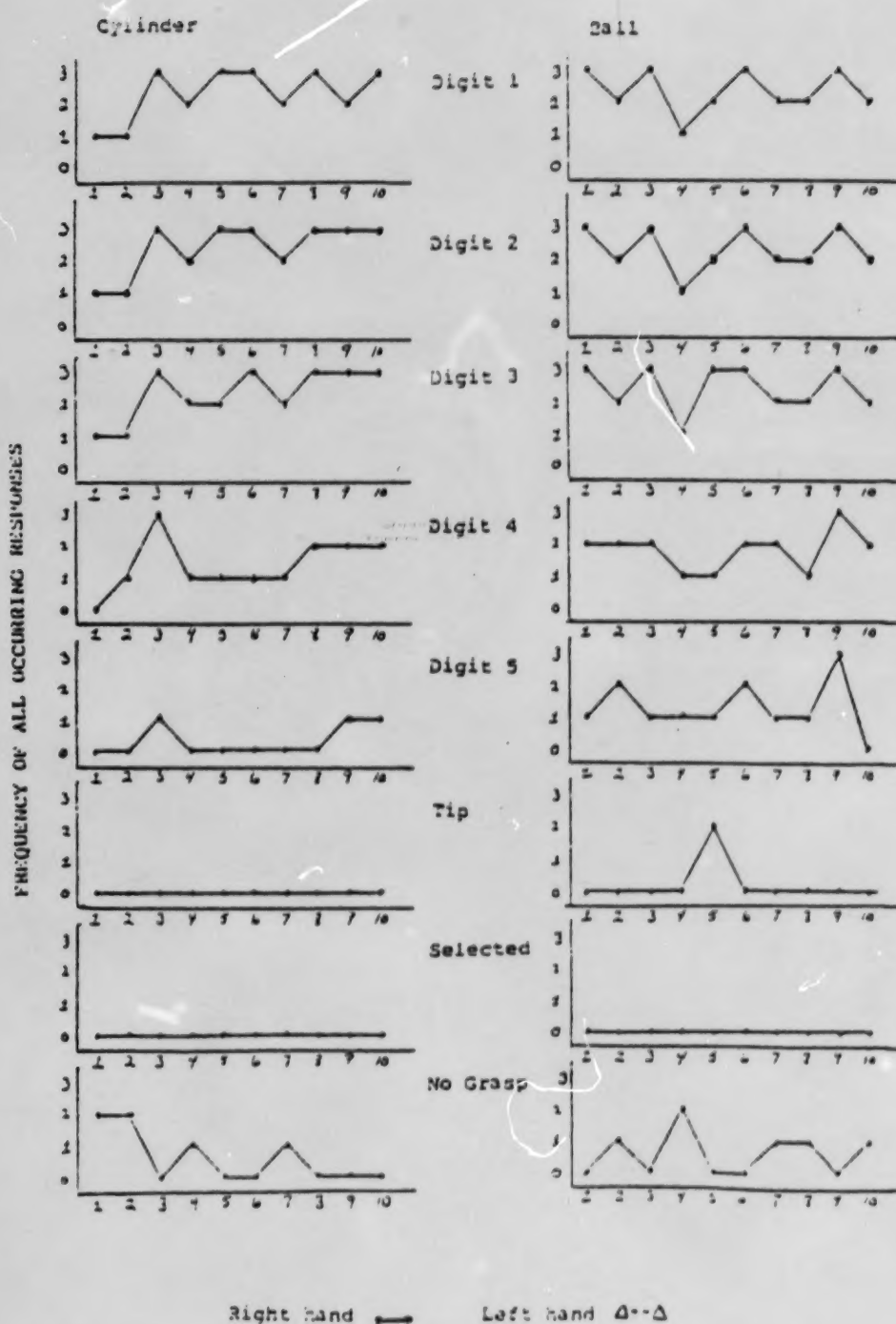


Figure 3. Frequency of behavior responses across cylinder and ball for Subject 2 (Janice)

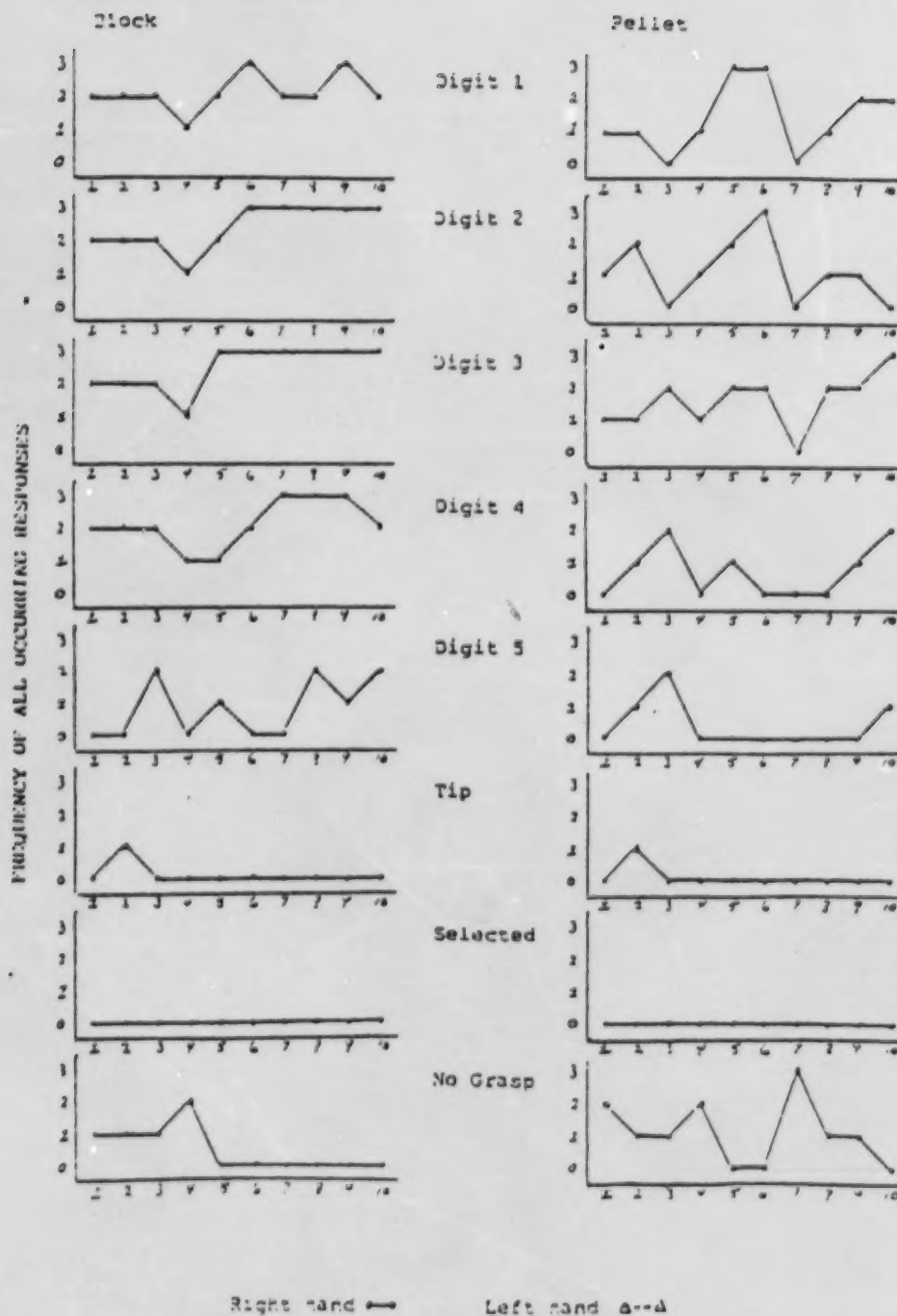


Figure 4. Frequency of behavior responses across block and pellet for Subject 2 (Janice)

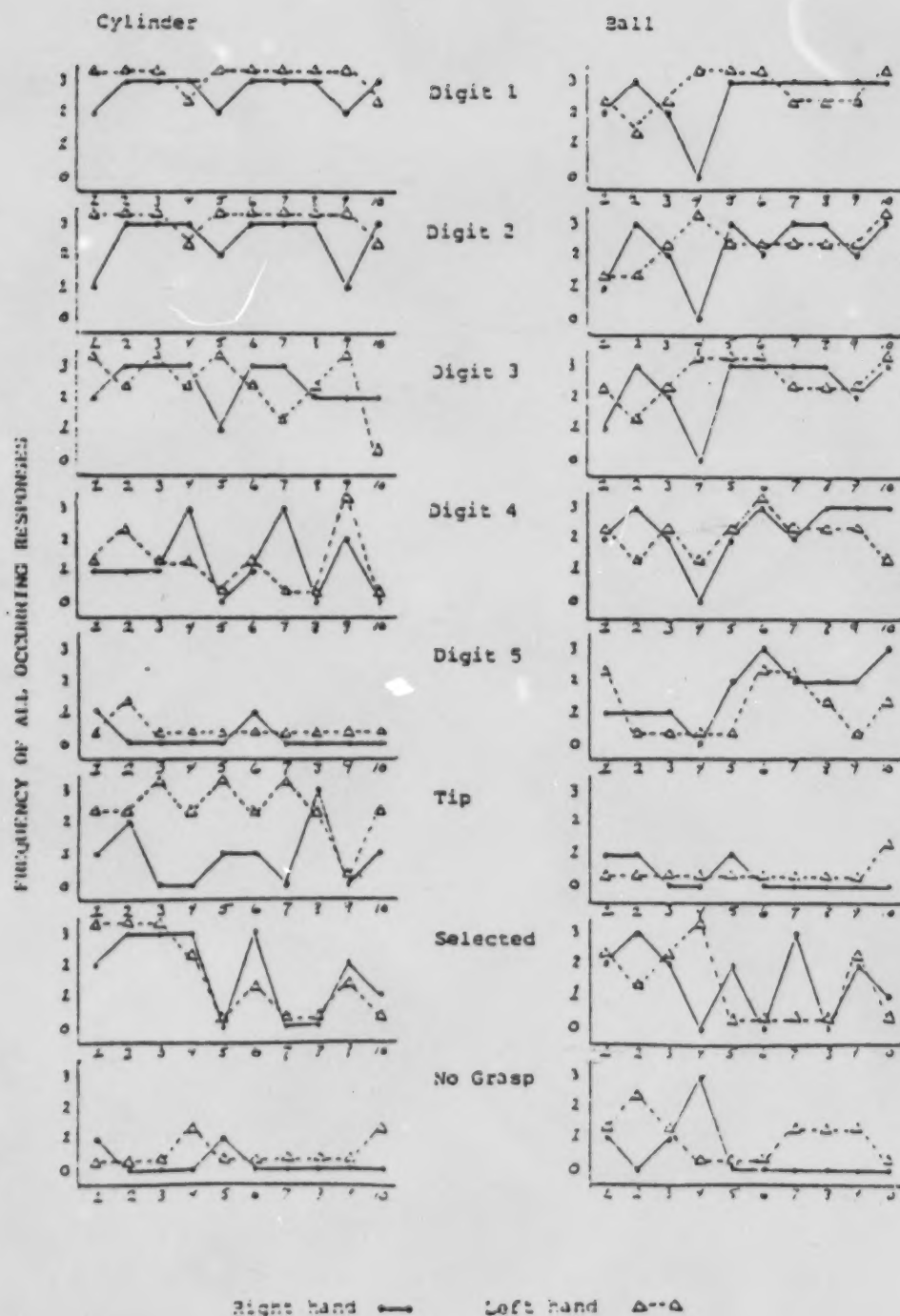


Figure 5. Frequency of behavior responses across cylinder and ball for Subject 3 (Jack)

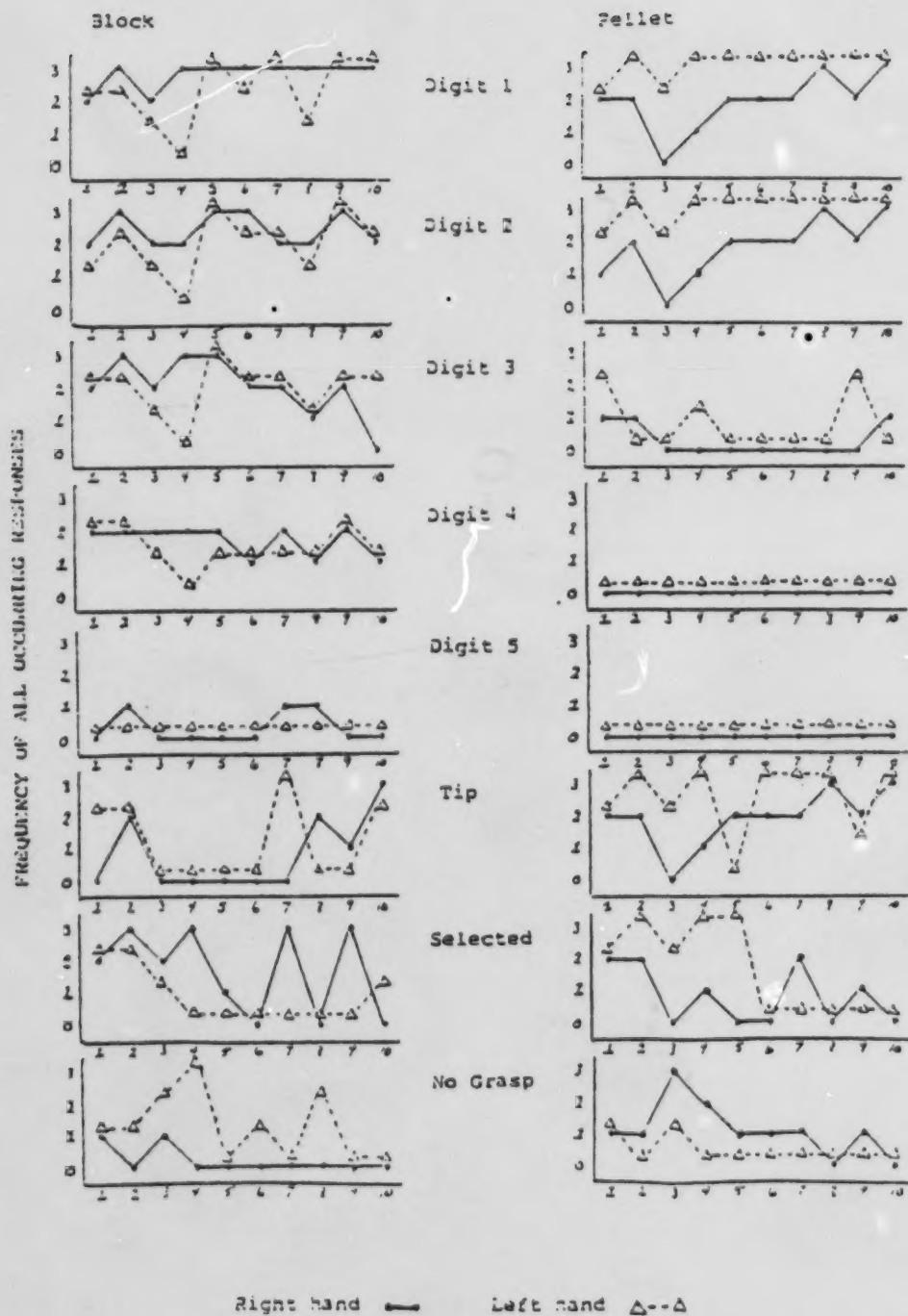


Figure 6. Frequency of behavior responses across block and pellet for Subject 3 (Jack)

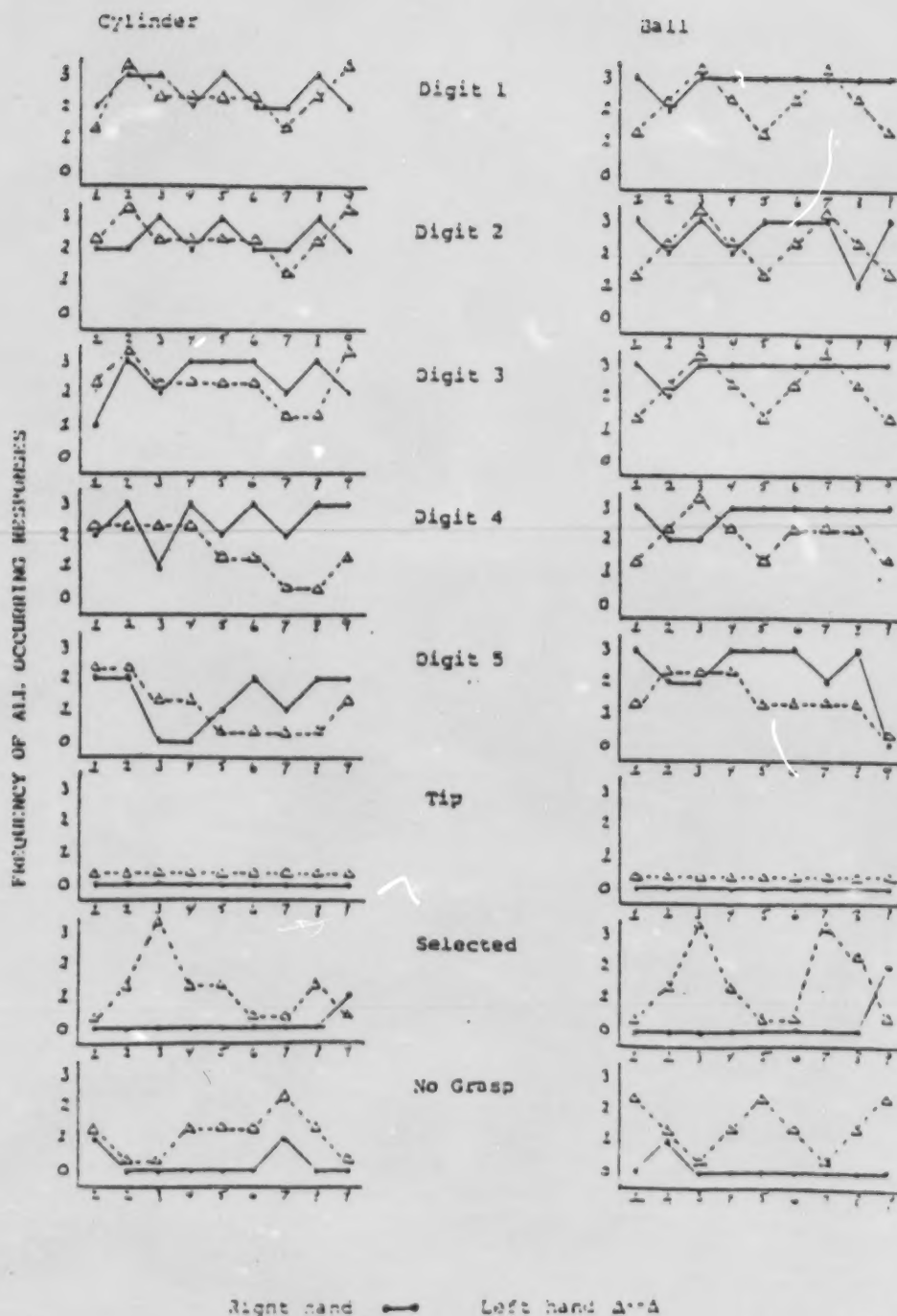


Figure 7. Frequency of behavior responses across cylinder and ball for Subject 4 (Scott)

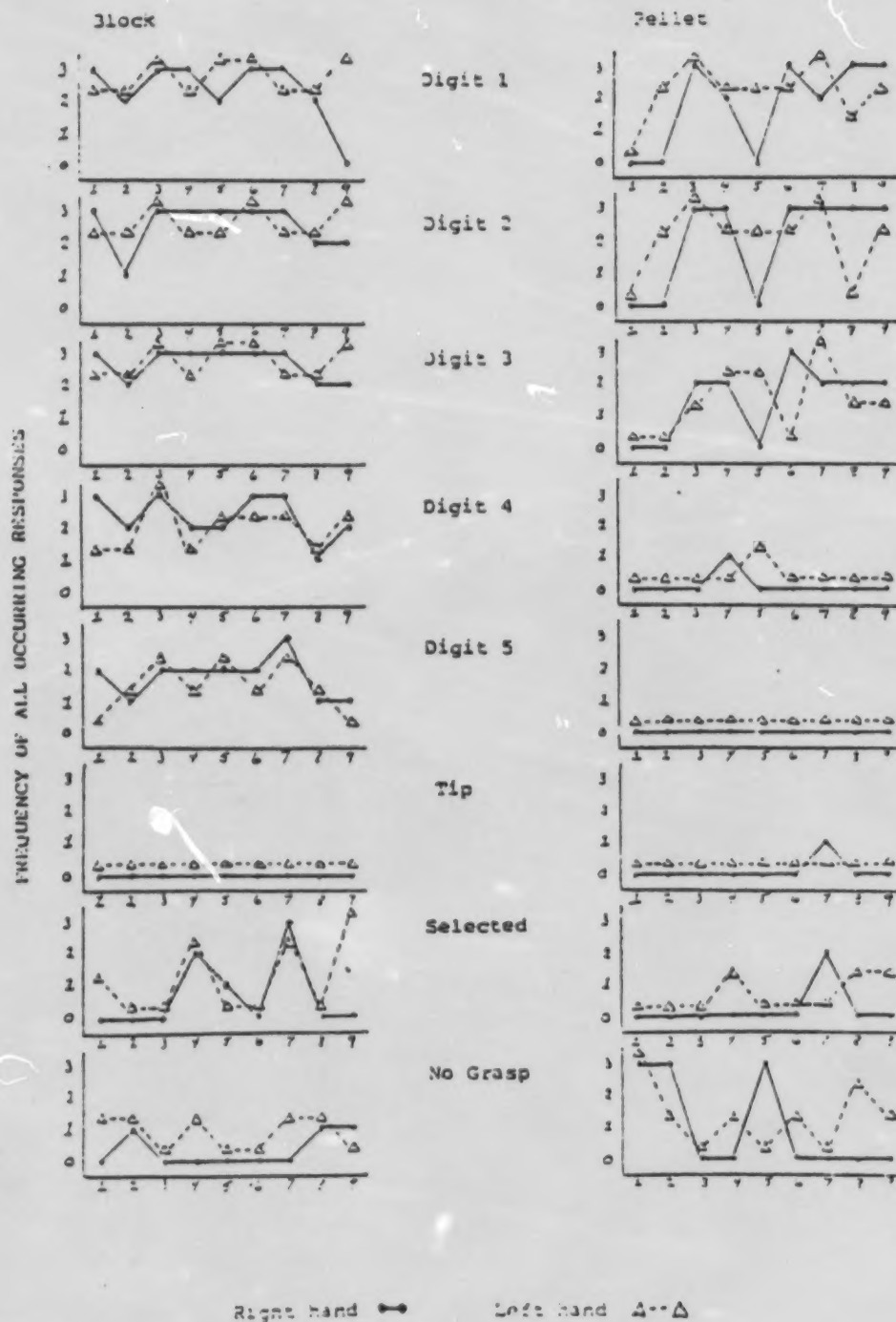


Figure 8. Frequency of behavior responses across block and pellet for Subject 4 (Scott)

sponses fluctuate across both hands with the cylinder. A decrease in No Grasp trials is noted for both hands with the ball, particularly after session 6. Figure 2 presents data for responses across all descriptors with the block and pellet. This figure illustrates constant or increasing trends in radial digit use with both stimulus objects. Fluctuation is noted prior to the sixth session with consistent frequencies in the final four sessions. Frequency of Digit 3 use with the pellet is erratic, showing an increase with the left hand and a decrease with the right hand. A slight decrease in tip use frequency is noted with the block. A general increasing trend is noted in tip use frequency with the pellet. Right hand selection is consistently high with the pellet, but fluctuates for the left hand with the pellet and both hands with the block. No Grasp trials for the pellet are consistently low, with three No Grasp trials noted across all sessions. Greater fluctuation is noted with the block. This fluctuation is seen in the first six sessions with zero No Grasp trials seen in the final four sessions.

Subject 2 (Janice). Performance data are shown for 10 sessions. Data for responses across all descriptors with the cylinder and ball stimulus objects are represented in Figure 3. This figure illustrates an overall increasing trend in radial digit use with the cylinder. An erratic but level trend in radial digit use is noted with the ball. Tip use with both objects is consistently zero except for two instances with the ball in session 5. Right hand selection is a constant zero across both objects. No Grasp responses fluctuate across both objects. A decrease in No Grasp trials is noted with the cylinder. Figure 4 presents data for responses across all descriptors with the block and pellet. This figure illustrates increasing radial digit use with the

block and erratic radial digit use with the pellet. Tip use for both objects is a constant zero except for one instance with each object in session 2. Right hand selection is a constant zero across both objects. A decreasing trend in No Grasp responses is noted with the block. No Grasp responses with the pellet are erratic but show a general decreasing trend.

Subject 3 (Jack). Performance data are shown for 10 sessions. Data for responses across all descriptors with the cylinder and ball stimulus objects are represented in Figure 5. This figure illustrates constant trends in radial digit use with both objects. Greater fluctuation in radial digit use is noted with the right hand. Tip use is fairly constant for both hands with the ball. Consistently high tip use is noted for the left hand with the ball. Right hand tip use is irregular with the ball. Both hands are selected frequently in the first four sessions, followed by a sharp decrease in left hand selection with both objects. Greater fluctuation of right hand selection is apparent for both objects. No Grasp responses are consistently low with the cylinder but are irregular with the ball. Figure 6 presents data for responses across all descriptors with the block and pellet. This figure illustrates increasing radial digit use with the pellet for the right hand. Constant or decreasing radial digit use is noted with the block for the right hand. Radial digit use with the left hand is constant with the pellet but fluctuates with the block. Left hand tip use frequency fluctuates with the pellet but shows a general increasing trend for both hands with the block and for the right hand with the pellet. A decrease in No Grasp responses is noted for both hands with the pellet. No Grasp responses with the block are consistent with the right hand but fluctuate with the left hand.

Subject 4 (Scott). Performance data are shown for nine sessions. Data for responses across all descriptors with the cylinder and ball stimulus objects are represented in Figure 7. This figure illustrates fluctuating radial digit use with both hands with the cylinder. Right hand radial digit use is consistent with Digits 1 and 3 with the ball. Fluctuation is noted with Digit 2 with the ball. Left hand radial digit performance with the ball appears to be influenced by the high frequency of No Grasp and selected trials. Tip frequency is zero for both hands with both objects. A higher frequency of selection is noted with the left hand. The right hand is selected only in session 9 with either stimulus object. No Grasp responses are fairly constant with the right hand but fluctuate with the left hand with both the cylinder and the ball. Figure 8 presents data for responses across all descriptors with the block and pellet. This figure illustrates fairly constant radial digit use with both hands with the block. A general increase in radial digit use with both hands is noted for the pellet. Tip frequency is zero except for a single right hand trial with the pellet. A high frequency of right and left hand selection is noted with the block. The right hand is selected one trial and the left hand is selected in three trials with the pellet. No Grasp responses are fairly constant with the block. Left hand No Grasp trials with the pellet are inconsistent. A decreasing trend in No Grasp trials is noted with the right hand with the pellet.

Discussion

Interobserver Reliability

These procedures obtained high interobserver reliability across several descriptors and digits. This reliability was affected by observer

training and practice prior to initiating data collection with the children. Observers who participated in training and practice sessions appeared to produce higher interobserver reliability. Interobserver reliability was also affected by the educational background of the observer.

A three week vacation from school elapsed between data point 4 and data point 5 for Subjects 2 and 3. Prior to the vacation, parents were observers for these subjects. Neither parent was able to serve as an observer after the vacation. They were replaced by the graduate assistant observing Subject 4. Reliability with the parent ranged from 71%-100% with a mean reliability of 98% for Subject 2. Reliability for Subject 2 with the graduate student ranged from 88%-100% with a mean reliability of 99%. Reliability with the parent ranged from 71%-100% with a mean reliability of 95% for Subject 3. Reliability for Subject 3 with the graduate student ranged from 85%-100% with a mean reliability of 98%.

Interobserver reliability for digit use ranged from 91%-100% with a mean reliability of 96% for digits 2 through 4 and 97% for digit 1. Overall mean reliability for digit use was 96%. Interobserver reliability for descriptors ranged from 93%-100% with a mean reliability of 96% for Palm/Tip, 97% for Selected, and 100% for No Grasp. Overall mean reliability for descriptors was 97%. Interobserver reliability for object descriptors ranged from 93%-100% with a mean reliability of 96% for the cylinder and block, 97% for the ball and 98% for the pellet. Overall mean reliability for object descriptors was 97%. Interobserver reliability for digit use with the right hand ranged from 84%-100% with a mean reliability of 96%. Interobserver reliability for all descriptors across the right hand ranged from 92%-100% with a mean reliability of

96%. Overall mean reliability with the right hand was 96%. Interobserver reliability for all descriptors across the left hand ranged from 93%-100% with a mean reliability of 97%. Overall mean reliability with the left hand was 96%.

In summary, explicit descriptions and guidelines for procedures contributed to the high reliability figures in this study. The exactness of these procedural descriptions and guidelines may render the assessment procedures more practical for classroom teachers.

Performance Data

In the present study, cylinder, ball, block and pellet shapes were used as stimulus objects. Neese (Note 1) used cylinder, ring, block and pellet shapes as stimulus objects. Distinct digit use and frequency patterns were obtained for each shape. Although grasp topography for the ball and block were similar, overall tip frequency was higher with the block. The ball was generally grasped with digits 1 through 4 or 1 through 5. The block was generally grasped with digits 1 through 3 or 1 through 4.

Grasp responses were elicited using the techniques described in the methods section. It was found that all subjects tired quickly unless trials varied across stimulus objects or hands. the examiner needed to be alert to the child's restlessness. With practice, the examiner and observer were able to complete most sessions in 10 to 12 minutes. Short sessions tended to produce fewer No Grasp trials.

Hand preference was indicated by the selected descriptor. The hand labeled preferred by the child's parent or teacher was always the hand selected most frequently in the assessment procedures.

The present study employed a single 10 second measurement interval per trial. This change decreased the overall length of the session and involved less stopwatch manipulation. Minimal stopwatch manipulation decreased training and practice time for observers. Single initiation and termination points for the trial may have contributed to the high reliability figures of this study as it diverted the observers' attention from the child to the stopwatch less frequently.

The present study agreed with Neese's findings concerning reliability with the fifth digit and the correlation between tip frequency and radial digit use. The fifth digit was the least reliable digit for all subjects. Reliability across subjects for the fifth digit ranged from 79%-100% with a mean reliability of 94%. Mean reliability for digits 1 through 4 was either 96% or 97%.

As implied by Neese, the longitudinal data obtained in this study showed developmental changes in grasp skills. Subject 1 (normally developing infant) and Subject 4 (handicapped child) exhibited gradual ulnar to radial progressions of digit use. Tip frequency was higher in the final sessions for Subjects 1 and 3. This finding also supports literature which indicated a correlation between developmentally higher grasp behaviors and increased tip and radial digit use.

Limitations

Cliff's summary (1979) of grasp behavior was used to show the subjects' grasp development over time. The major problems with this procedure were related to correlating scored behaviors to types of grasp presented by Cliff. Behavior descriptors used in this measurement tool presented behavior topographies. However, within each behavior descriptor qualitative differences were not apparent. When Subject 3 grasped the pellet with a Refined Pincer Grasp digits

1, 2 and 3 were marked on the data sheet. Subject 4 grasped the pellet with a Vertical Pincer Grasp, and again, digits 1, 2 and 3 were marked on the data sheet. Although Cliff suggested a four week developmental difference between the two grasps, the recorded observations of this procedure indicated identical grasp behaviors.

A second limitation in this procedure was the failure of scored behaviors to describe development across time. Subject 1 (nonhandicapped) progressed from the Palm Grasp to the Superior Hand Grasp to the Inferior Forefinger Grasp across the three months of data collection. This developmental progression was not apparent in the data, since digits 1, 2 and 3 and the palm were used in all three grasps.

Anecdotal records indicated developmental progression in grasp behavior across time for Subjects 1, 3 and 4. Analysis of the digit use and tip frequency data collected by this assessment procedure did not reflect these changes.

The second limitation was complicated by the procedure's hand divisions. The size of the stimulus object in comparison to the child's hand caused the stimulus object to touch parts of the digits divided into the palm area. This digit division equated the higher level Inferior Forefinger Grasp to the identically scored, but developmentally lower, Superior Hand Grasp. Accurate tracking of grasp development may have been reduced as a result of the hand division in the procedures.

A third apparent limitation of the procedures was the disregard of radial vs. ulnar hand approach to the stimulus object. Erhardt (1974), Cliff (1979) and Gesell (1940) viewed approach to the object as a possible developmental indicator for grasp behavior. These procedures did not monitor approach in conjunction with digit use. Subject 4 exhibited the

more mature radial approach to simulate objects but severe motor impairments caused him to grasp with digits 2, 3 and 4. Data from the procedures showed a lower ulnar grasp even though Subject 4 was attempting the developmentally higher radial grasp.

Several recommendations for further research can be made. A larger number of severely multiply handicapped subjects should be assessed, as well as a larger group of normal subjects. Longitudinal research should be conducted in unstructured sessions in the home, classroom and community to reflect the child's degree of prehensile skill generalization across settings. Data collection in dispersed trials (Mulligan, Guess, Holvoet and Brown, Note 2) may decrease the possible negative effects of mass trial assessment.

Limitations inherent in a digit use/tip frequency observation implies the need for further research using Cliff (1979), Napier (1956) or Kamakura, Matsuo, Ishii, Mitsuboshi and Miura's (1980) grasp descriptions as indicators of grasp development.

Reference Notes

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A REPLICATION STUDY:
Quantitative Assessment of Release Among
Severely Handicapped and Nonhandicapped Infants and Children¹

by
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and
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¹The procedures and data reported in this study were taken from a master's thesis by Sally Courte that was submitted to the Department of Special Education, University of Kansas, in March, 1981.

Overview of Measurement Procedures

A complete description of the measurement procedures used in this study is found in pages FM(RL)1 to FM(RL)22 of Volume I, Assessment Procedures for Selected Developmental Milestones. Procedures were developed to measure release in the sitting, sidelying, and standing positions. Measureable release was defined as (1) an object being retained for at least 2 seconds and (2) an object beginning to move out of the hand, resulting in loss of contact with the hand. The descriptions observed across the stimulus objects included fingers used, use of right or left hand, type of grasp, use of a palmar or fingertip grasp, hand position, supported or unsupported arm, release against a surface or no surface, release into or outside a container, no release or immediate release.

Each session consisted of 24 trials, divided into six trials with each stimulus item (rod, ball, cube, pellet). A trial began when the stimulus item had been grasped and was free of the work surface for 2 seconds. When the stimulus item has been picked up, and the object was above the work surface, the examiner began timing the trial by self counting aloud. If the test object was retained for 2 seconds, the examiner gave the cues for release. After the cues were given, the examiner began timing with a stopwatch. The trial ended when the test object was released or 60 seconds had elapsed. If the object was not retained for 2 seconds, immediate release data was recorded and timing was stopped. Sessions were repeated on a weekly basis. Trials were distributed throughout the week, depending on the subject's ability to tolerate the testing situation.

Three procedures were used to obtain the prerequisite grasp response and three procedures were used to encourage release. One practice trial with each test object was used before beginning the observation trials. This procedure exposed the subject to the desired responses and helped the examiner to select appropriate cues. Trials occasionally were repeated. Trials were alternated across stimulus items to maintain the motivation of the subject to cooperate with the test procedure. An equal number of trials with the right and left hands were obtained.

Obtaining Prerequisite Response

When the subject was positioned and ready to begin the trial, the examiner gained the child's attention by passing the stimulus item through the subject's visual field, tapping the test object on the work surface or the hand. Method A was used if the subject demonstrated voluntary grasp of at least 1 stimulus item. Method B was used if the subject did not demonstrate voluntary grasp within 10 seconds after a stimulus item was presented. Method C was used if the subject consistently grasped the test object with the same hand in the first 3 trials with a given test object.

Method A. After gaining the subject's attention and placing the stimulus item at midline, the examiner encouraged the child to grasp the object with a verbal cue, such as "Pick up" and modeled the response. The examiner waited 5 seconds.

If the subject did not grasp the object within 5 seconds, the examiner repeated the visual, verbal and auditory cues. If the subject did not grasp the object within 10 seconds, Method B was used.

Method B. After gaining the subject's attention, the examiner gave verbal cues and signed a request to "Take." The examiner used any

appropriate method to elicit an automatic grasping response (e.g., placing the object firmly in the subject's hand).

Method C. If the subject consistently used the right or left hand during the first 3 trials with a given stimulus item, the examiner "selected" the other hand in subsequent trials.

After gaining the subject's attention, the examiner asked or signed for the subject to take the stimulus item. The test object was presented well to the right or left of midline.

If the subject did not grasp the object within 10 seconds, the examiner used Method B.

If the child persistently transferred or crossed midline to grasp the object, it was occasionally necessary to restrain the hand. This procedure could be aversive to some children and was used only as a last resort. The examiner needed to consider the advantages of an equal number of trials with the right and left hand against the need for the subject's cooperation. If the subject had difficulty raising the arm, the examiner propped the arms forward on the table top, or manually supported the arm at the elbow.

Encouraging Release

Two procedures were used to encourage releast of stimulus items. Method A was used with a container. Method B was used without a container.

Method A. If the subject released the test object into a container within 60 seconds in at least 2 practice trials, the container was used in subsequent trials.

The container was placed on the work surface at midline. After gaining the subject's attention, the examiner presented the test object above the work surface at midline, giving appropriate cues to "Take."

When the subject grasped the test object, the examiner tapped the container and gave appropriate cues to "Put in" while modeling the response.

If the subject did not release the test object into the container within 10 seconds, a small edible or novel item was placed in the container to increase the probability of response.

During practice trials, the examiner physically prompted the subject to place the object into the container. If the subject transferred, the trial was discarded. If transferring persisted, the examiner placed a non-stimulating object in the other hand or restrained the hand. To prevent eliciting an involuntary response, the examiner avoided touching the subject's forearm or hand when giving the cues to release.

Method B. If the subject did not release the test object into a container within 60 seconds in at least 2 practice trials the container was not used. When the test object had been grasped, the examiner gained the subject's attention by any appropriate method.

The examiner said or signed "Give me _____", holding the palm up. If the subject did not release within 5 seconds, a distractor was presented. The subject's attention was directed toward the second stimulus item (e.g., holding the distractor at eye level, tapping the object on the work surface). Appropriate cues were given to "Look" or the examiner touched the subject's chest with the distractor. If the subject reached with the non-desired arm, a second distractor was presented. If the subject did not release the object within 10 seconds cues were repeated.

If the subject transferred the object to the other hand, the trial was discarded. If transferring persisted, a non-stimulating object was placed in the other hand or the hand was restrained in subsequent trials.

Subjects

The subjects selected for this study consisted of one full term infant without neurological or sensory deficit and three developmentally delayed children. All the subjects demonstrated the ability to voluntarily grasp and release objects with at least one hand.

Subject 1 was a normally developing female. She was 5 months of age at the beginning of the study.

Subject 2 was a 4 year old male, with a diagnosis of microcephaly, delayed physical and psychomotor development. In fine motor skills, the subject was functioning at approximately a 10½ to 11 month level of development.

Subject 3 was a 6 year 5 month old female, with a diagnosis of spastic quadriparetic cerebral palsy, more involved on the left. In fine motor skills, she was functioning at approximately a 4-10 month level of development.

Subject 4 was a 3 year 5 month old male with a diagnosis of spastic quadriparetic cerebral palsy without evidence of mental retardation. In fine motor skills, he was functioning at approximately a 1 year 1 month to 1 year 6 month level of development.

Procedures for Obtaining Measures of Reliability

Reliability measures were taken through independent observation by the examiner and at least one other observer. The same unbiased observer was present at all sessions. Within the context of this study, an unbiased observer was someone not connected with the Early Childhood Institute (ECI), University of Kansas, Lawrence, Kansas. Reliability measures reflected the percent of agreement on the occurrence of the behaviors observed.

Two measures of reliability were taken: 1) mean percent of reliability per descriptor across trials; and 2) mean percent of reliability per stimulus item across descriptors. Agreements on occurrence of behaviors were compared to the examiner's data. Individual reliability scores per descriptor and per stimulus item in each trial were calculated in the following way:

$$\frac{\text{\#Agreements}}{\text{\#Agreements} + \text{\#Disagreements}} \times 100 = \% \text{ reliability}$$

Other reliability scores were obtained through a hierarchal system of averaging. Individual trial scores per stimulus item and descriptor scores were averaged to obtain mean session reliability scores. Mean session reliability scores averaged to obtain total reliability scores for each subject. Mean session reliability scores for each descriptor and stimulus item were averaged to obtain overall reliability scores per descriptor and per stimulus item. Total mean session scores per subject were averaged to obtain an overall reliability score for all subjects. Total mean session scores in one position were averaged to obtain an overall reliability score per position. Total mean session scores for the handicapped children were averaged to obtain comparative data between three handicapped children and one non-handicapped infant.

Results

Reliability Measures in Sitting Position

Three subjects were assessed in sitting position. Subject 1 (non-handicapped) and Subject 2 (handicapped) were measured in floor sitting position. Subject 3 (handicapped) was measured in supported chair sitting position.

Subject 1. Measures of interobserver reliability across materials, descriptors, and sessions for Subject 1 are presented in Table 1. The

TABLE 1
Interobserver Reliability Scores Across Materials, Descriptors, and Sessions
for Subject 1 in Floor Sitting Position

Stimulus Item	R/L	Fingers					V/S/E	P/T	Hand Position	S/U	A/N	C/O	IR/NR	Mean Reliability
		1	2	3	4	5								
Rod	100	85	92	100	97	90	94	100	90	96	96	100	100	95
Ball	100	96	97	97	96	94	93	91	77	95	74	97	98	93
Cube	100	91	100	99	91	85	92	91	80	100	81	100	100	92
Pellet	100	83	87	88	81	91	90	72	91	98	87	98	97	89
Mean Reliability	100	89	94	96	90	90	92	89	85	97	85	99	99	93/93
Overall Reliability														93

mean reliability score per descriptors was 93%, with a range of 85%-100%. The mean reliability score per stimulus item was 93%, with a range of 89%-95%. Total session reliability was 93%. Sessions were divided into 2 equal parts in 5 out of 15 sessions, with 12 trials administered in each half session.

Subject 2. Measures of interobserver reliability across materials, descriptors, and sessions for Subject 2 are presented in Table 2. The mean reliability score per descriptors was 87%, with a range of 74%-99%. The mean reliability score per stimulus items was 87%, with a range of 82%-90%. Total session reliability was 87%.

Subject 3. Measures of interobserver reliability across materials, descriptors, and sessions for Subject 3 are presented in Table 3. The mean reliability score per descriptors was 91%, with a range of 78%-100%. The mean reliability score per stimulus items was 90%, with a range of 83%-92%. Total session reliability was 91%.

Reliability Measures in Sidelying Position

Subject 4. Measures of interobserver reliability across materials, descriptors, and sessions for Subject 4 in the sidelying position are presented in Table 4. The mean reliability score per descriptors was 94%, with a range of 79%-100%. The mean reliability score per stimulus items was 94%, with a range of 90%-96%. Total session reliability was 94%.

Overall Reliability

Table 5 represents session reliability scores across all subjects and positions. The total session reliability score for the non-handicapped subject was 93%. The mean session reliability score for the handicapped subjects was 91%. The mean session reliability for measurements in

TABLE 2

Interobserver Reliability Scores Across Materials, Descriptors, and Sessions
for Subject 2 in Floor Sitting Position

Stimulus Item	R/L	Fingers					V/S/E	P/T	Hand Position	S/U	A/N	C/O	IR/NR	Mean Reliability
		1	2	3	4	5								
Rod	100	91	98	95	86	72	83	81	83	100	86	100	100	90
Ball	100	96	91	96	96	66	98	93	83	100	84	100	100	93
Cube	96	99	87	90	88	67	92	87	63	95	80	98	50	84
Pellet	100	86	88	43	93	89	82	75	73	83	72	90	80	82
Mean Reliability	99	93	91	81	91	74	90	84	76	95	81	97	83	87/87
Overall Reliability														87

FM(RL)10

TABLE 3

Interobserver Reliability Scores Across Materials, Descriptors, and Sessions
for Subject 3 in Supported Sitting Position

Stimulus Item	R/L 1	Fingers					V/S/E	P/T	Hand Position	S/U	A/N	C/O	IR/NR	Mean Reliability
		1	2	3	4	5								
Rod	100	86	85	97	88	81	93	95	79	96	88	100	96	91
Ball	100	87	94	100	96	77	94	94	74	100	84	97	100	92
Cube	100	81	95	97	83	63	90	95	88	97	75	100	93	83
Pellet	100	83	92	98	98	93	89	88	77	96	83	100	100	92
Mean Reliability	100	84	92	98	91	79	92	93	80	97	83	99	97	91/90
Overall Reliability														91

FM(RL)11

TABLE 4

Interobserver Reliability Scores Across Materials, Descriptors, and Sessions
for Subject 3 in Supported Sitting Position

Stimulus Item	R/L	Fingers					V/S/E	P/T	Hand Position	S/U	A/N	C/O	IR/NR	Mean Reliability
		1	2	3	4	5								
Rod	100	100	98	98	93	85	100	96	82	100	89	100	100	95
Ball	100	94	98	98	96	92	86	98	77	100	92	100	100	95
Cube	100	93	98	100	93	91	96	98	79	100	85	100	--	94
Pellet	100	89	85	86	91	89	89	100	73	100	83	100	100	90
Mean Reliability	100	94	95	96	93	89	93	98	78	100	87	100	100	94/94
Overall Reliability														94

FM(RL)12

TABLE 5

Overall Interobserver Reliability Scores
for All Subjects Across Positions and Sessions

Subject	Floor Sitting	Supported Sitting	Sidelying	Mean Reliability
1	93%			93%
2	87%			
3		91%		91%
4			94%	
Mean Reliability	90%	91%	94%	
Overall Reliability				92%

floor sitting was 90%. The total session score for sidelying position was 94%. Overall reliability across all subjects in all positions was 92%.

Discussion

Interobserver Reliability

Overall reliability for 3 subjects in sitting position and 1 subject in sidelying position was 92%, with a range of 89%-94%. Total mean reliability per stimulus item was 92%, with a range of 82% to 95%. Total mean reliability per descriptor was 92%, with a range of 79% to 100%. The lowest score was obtained for hand position across all 4 subjects. Data on the use of the 5th digit yielded session reliability scores below 80% with 2 out of 3 handicapped subjects. Scattered low mean reliability scores per descriptor were obtained for palmar or fingertip grasp and release against a surface or no surface. The first 1 to 3 sessions were incomplete with 3 out of 4 subjects.

Six factors appeared to influence reliability scores. These variables will be discussed in order of importance to this investigator. Insufficient training and practice with the assessment procedure may have been responsible for the incomplete initial sessions. Ambiguous behavioral definitions of hand position may have affected reliability scores for this descriptor. Observer position may have affected reliability on the Fingers used, Palmar or Fingertip grasp and Release against a surface or Against no surface descriptors. Unless the observers moved quickly, their view of the stimulus item was obstructed by the subject's hand. this variable was important in observation of Subject 2, who exhibited hypermobility of the joints.

The recording procedure for Immediate release affected reliability scores for other descriptors. Since most other behaviors were not recorded if Immediate release occurred, a disagreement on Immediate release automatically depressed other reliability scores. Restraint of the preferred hand to obtain trials with the other hand and prevent transfers was not well tolerated by Subject 2, and may have affected reliability. Intra-subject variables, such as illness, motivation, ability to attend may have indirectly affected individual reliability scores.

Two factors assumed to have a possible influence on reliability appeared to have little effect. Overall mean reliability scores across sitting and sidelying positions were above 90%. This finding suggests that position did not affect reliability in this sample. The use of split sessions with Subject 1 did not appear to influence reliability. Reliability scores increased across 3 out of 4 stimulus items. With the pellet, the mean reliability score for sessions 7 through 11 was 90%. Mean reliability scores of 89% were obtained for the first and third parts of the assessment period.

This assessment is reliable and sensitive to a wide spectrum of fine motor skills, but is limited in measurement of target behaviors (e.g., release components). Omission of elicited grasp and digit use descriptors might permit tracking of all the release behaviors contained within the procedure. Measurement of release into a small container would provide a more complete assessment of release skills and possibly help maintain motivation in higher functioning children. For lower functioning children, an approximation of release into a container might be more appropriate (e.g., placing the object in the examiner's hand or on the work surface).

The sidelying position may be inappropriate for measurement of most release skills. This position interferes with visually guided release into a container. Furthermore, if the subject's optimal position is sidelying, measurement of release may be premature.

Performance Data

Results of performance with Subject 4 did not yield data on hand preference. Approximately equal levels of functional competence with right and left hand were observed in high total mean frequency of occurrence of the following descriptors: 1) Unsupported arm, 2) Voluntary grasp (Digits 1-4/5) with the rod, ball and cube, and 3) Measurable response.

With the right hand, a palm down position varied with a thumb down position across the rod, ball and cube. Responses with the pellet were more variable. With the left hand, a palm down position was always used. Voluntary grasp occurred with a high total mean frequency on the right hand and with moderately high total mean frequency with the left hand. The use of an elicited grasp decreased with the right and left hands. This finding suggests the presence of emerging skills in voluntary grasp. Data on finger use with the pellet revealed that digits 2/3/4/5 were used most often with the right hand. Digit use with the pellet on the left was variable. Digits 1-3 and 1-2 were used more frequently with the left hand. Fingertip grasp rarely occurred on the right and did not occur on the left.

Release against a surface occurred with high total mean frequency on the right and left. Release into a container occurred with moderately high frequency with the rod, ball and cube with the right and left hands. Releases with the pellet were almost evenly divided between

inside and outside a container. Release into a container tended to decrease with the right hand and was variable with the left hand. Immediate release and No release responses occurred with low total mean frequency.

Intervening variables may have influenced performance. The side-lying position was not well tolerated by this subject. The position may have affected performance by altering the position of the body to the container. The subject's view of the top of the container was obstructed. Use of an elicited grasp with the pellet correlated with use of digits 1-3 and 1-2 in 6 out of 8 occurrences of elicited grasp on the left. On the right, correlation was observed in 1 out of 7 elicited grasp responses. Finger use data with the pellet on the left may be distorted. Stimulus control problems were suggested in the decreased occurrence of release into a container. The subject ate the pellet and placed other stimulus items in a variety of locations other than the container with cheerful non-compliance. Performance data were consistent with clinical findings in all areas except digit use with the pellet.

Limitations

In the original study it was stated that one of the major problems in assessment of handicapped children is differentiating between motor and cognitive components. That observation is supported by this investigator. Subjects 2 and 3 may have been penalized for a limited ability to attend and cooperate with the test procedure. On the other hand, both non-handicapped and handicapped subjects may have been penalized for adaptive behaviors that were inappropriate for the assessment procedure. Subjects 1 and 4 tended to eat the pellet and play with the other stimulus items. Subject 4 possessed release skills beyond the limits of this

TABLE 6

Summary of Performance Data on the Mean Percent of Occurrence of Release Behaviors
with 1 Non-Handicapped Infant and 3 Handicapped Children
with the Right and Left Hands: Approach Components

Subject	Stimulus Item	Voluntary Reach		Selected Hand		Unsupported Arm		Supported Arm		Palm Down		Hand Position				Palm Up	
		Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
1	Rod	95	36	5	57	100	100	0	0	88	65	8	33	0	0	5	0
	Ball	95	33	5	67	100	100	0	0	49	62	38	38	3	0	10	0
	Cube	98	31	2	69	100	100	0	0	66	50	32	48	0	0	2	2
	Pellet	100	11	0	89	100	100	0	0	10	17	91	83	0	0	0	0
Total Mean Percent		97	28	3	71	100	100	0	0	53	49	42	51	1	0	4	1
2	Rod	9	100	91	0	100	100	0	0	76	77	17	24	0	0	7	0
	Ball	48	79	52	21	81	100	19	0	79	69	17	31	5	0	0	0
	Cube	45	96	56	4	89	94	11	6	72	46	14	37	14	17	0	0
	Pellet	22	95	78	5	80	81	20	19	67	81	33	19	0	0	0	0
Total Mean Percent		31	93	69	8	86	94	13	6	74	68	20	28	5	4	2	0
3	Rod	96	0	4	100	100	0	0	100	78	58	20	0	0	42	4	0
	Ball	69	0	4	100	100	0	0	100	91	50	9	0	0	50	0	0
	Cube	100	0	0	100	38	0	48	100	84	75	17	0	0	25	0	0
	Pellet	100	0	0	100	17	0	83	100	83	67	8	0	0	33	0	0
Total Mean Percent		98	0	2	100	64	0	34	100	84	63	14	0	0	38	0	0
4	Rod	0	0	100	100	100	100	0	0	75	100	0	0	25	0	0	0
	Ball	0	0	100	100	100	100	0	0	46	100	0	0	50	0	4	0
	Cube	0	0	100	100	100	100	0	0	59	100	0	0	41	0	0	0
	Pellet	0	0	100	100	100	86	0	0	37	100	39	0	24	0	0	0
Total Mean Percent		0	0	100	100	100	97	0	0	54	100	10	0	35	0	1	0

TABLE 7

Summary of Performance Data on the Mean Percent of Occurrence of Release Behaviors
with 1 Non-Handicapped Infant and 3 Handicapped Children
with the Right and Left Hands: Release Components

Subject	Stimulus Item	Against a Surface		Against no Surface		Into a Container		Outside a Container		Immediate Release		No Release		Measurable Release	
		Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
1	Rod	0	24	100	76	9	11	91	89	12	24	31	14	57	62
	Ball	33	32	67	68	4	5	96	95	26	31	0	0	74	69
	Cube	29	31	71	69	16	6	84	94	15	29	4	2	10	69
	Pellet	83	85	16	16	3	2	90	98	22	22	7	0	73	76
	Total Mean Percent	36	42	64	57	10	6	90	94	19	27	11	4	71	69
2	Rod	31	23	70	77	0	8	100	92	24	8	5	0	71	92
	Ball	69	56	31	44	9	4	91	96	9	8	0	8	91	84
	Cube	28	44	72	56	17	17	83	83	6	8	0	4	95	87
	Pellet	10	19	90	81	13	9	87	91	39	14	11	0	50	86
	Total Mean Percent	35	36	66	65	10	10	90	91	20	10	4	3	77	87
3	Rod	61	33	40	67	33	42	67	58	4	57	4	0	92	43
	Ball	71	50	29	50	49	50	40	50	25	81	4	0	71	19
	Cube	79	13	21	86	74	63	26	38	19	76	0	0	81	24
	Pellet	56	52	45	48	46	71	54	29	17	19	0	19	82	67
	Total Mean Percent	68	37	34	63	51	57	47	44	15	59	2	5	83	38
4	Rod	79	86	17	15	71	83	29	17	4	8	4	0	92	92
	Ball	92	100	8	0	67	72	31	18	0	0	0	0	100	100
	Cube	96	95	4	5	85	81	15	19	0	0	0	0	100	100
	Pellet	85	100	15	0	43	52	57	48	4	0	0	0	96	100
	Total Mean Percent	88	95	11	5	67	72	35	28	2	2	1	0	97	98

TABLE 8

Summary of Performance Data on the Mean Percent of Occurrence of Release Behaviors
with 1 Non-Handicapped Infant and 3 Handicapped Children
with the Right and Left Hands: Grasp Components

Subject	Stimulus Item	Voluntary Grasp		Elicited Grasp		1-4/5		Fingers Used 1-3		1-2		2/3/4/5		Palmar Grasp		Fingertip Grasp	
		Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
1	Rod	100	93	0	7	95	86	5	3	0	0	0	11	100	96	0	4
	Ball	100	93	0	7	100	100	0	0	0	0	0	0	100	96	0	4
	Cube	100	81	2	19	97	69	0	4	0	0	3	27	94	81	6	19
	Pellet	100	89	0	8	11	13	21	26	6	10	62	51	26	35	74	65
Total Mean Percent		100	89	1	11	76	67	7	8	2	3	16	22	80	76	20	23
2	Rod	91	100	9	0	88	82	7	4	0	0	5	15	100	86	0	15
	Ball	90	100	10	0	100	95	0	0	0	0	0	5	90	100	10	0
	Cube	100	100	0	0	72	79	22	15	0	6	0	0	95	96	6	4
	Pellet	83	95	17	5	0	5	53	52	37	38	0	5	93	81	6	19
Total Mean Percent		91	99	9	1	65	65	18	18	9	11	3	6	95	91	6	10
3	Rod	100	0	0	100	81	50	10	16	0	25	8	8	92	100	8	0
	Ball	100	0	0	100	74	100	5	0	5	0	17	0	100	100	0	0
	Cube	100	0	0	100	48	100	36	0	5	0	12	0	100	100	0	0
	Pellet	100	0	0	100	0	0	42	0	8	100	50	0	71	100	29	0
Total Mean Percent		100	0	0	100	51	63	23	4	5	31	22	2	91	100	9	0
4	Rod	100	84	0	16	100	100	0	0	0	0	0	0	100	100	0	0
	Ball	100	86	0	14	100	100	0	0	0	0	0	0	100	100	0	0
	Cube	100	90	0	10	89	81	11	14	0	0	0	5	96	100	4	0
	Pellet	74	62	20	38	4	0	0	38	11	48	85	14	100	100	0	0
Total Mean Percent		94	81	7	20	73	70	3	13	3	12	21	5	99	100	1	0

procedure. Clinical testing revealed that he could release a pellet into a small bottle. Lack of motivation became a problem in later sessions.

Varying the color of the stimulus items and expanding the number of distractors helped to improve motivation. Stimulus control problems could be reduced in other ways. Use of air dried Play-doh pellets might discourage future subjects from eating this stimulus item. Omitting the ball as a stimulus item would shorten assessment time and reduce opportunities for occurrence of adaptive but confounding behaviors. Use of a smooth dowel instead of a bristle block might reduce tactile defensiveness in some children and provide less novelty for others.

A REPLICATION STUDY:
Quantitative Assessment of Transfer Among
Severely Handicapped and Nonhandicapped Infants and Children¹

by
Margaret Cisco
and
Dave Esquith

¹The procedures and data reported in this study were taken from a Master's thesis by Margaret Cisco that was submitted to the Department of Special Education, University of Kansas, in August, 1980.

Overview of Assessment Procedures

A complete description of the measurement procedures used in this study is found on pages FM(T)1 to FM(T)25 of Volume I, Assessment Procedures for Selected Developmental Milestones. Procedures were developed to measure the transfer response, whether a third surface is used during transfer, and where the transfer is observed in relation to the child's body. Two procedures were followed to elicit transfer of the stimulus item from one hand to the other. In the first procedure the investigator placed a preferred item in the child's left hand and gave the verbal cue "Put it in this hand," simultaneously providing a verbal cue to the back of the right hand. In the second procedure, the investigator placed a preferred item in the child's left hand and offered a second more preferred stimulus on the child's left side. When completed successfully, the child transferred the first item to the right hand in order to grasp the second stimulus item. Both procedures may have been used within a session and conducted from both sides of the child.

For each trial the child was placed in a sitting, standing, or supine position, using whatever equipment was necessary to support and maintain the child comfortably. The horizontal plane directly in front of the child was sectioned off into three equally sized parts to indicate where the transfer took place in relation to the child's body. In addition to identifying the trisection where the transfer response occurred, the investigator noted whether (1) a third surface was used (e.g., mouth, chest, or table top), (2) the item remained in the receiving hand, (3) the item was in the child's mouth at the end of the recording interval, (4) the item was dropped, and (5) the midline was crossed in order to obtain the second stimulus object.

A single stopwatch was placed in view of both the investigator and reliability observer. The investigator started the watch simultaneously with presentation of the prompt to transfer. Four time intervals were specified during a trial: A pretrial interval, a 0-5 second interval, a 5-10 second interval, and a posttrial interval. If the child transferred the stimulus item with or without the use of a third surface but before the investigator prompted the transfer, the investigator entered the response as occurring during the pretrial interval. The 10 second interval following the investigator's prompt to transfer was broken into two equal parts, and the investigator noted the child's response in each of those 5 second intervals. If the child did not complete the transfer until the 10 second interval had lapsed the investigator recorded the response in the posttrial interval. The posttrial transfer was scored if it was completed within 5 seconds.

The present study did not change the methods used to elicit a transfer response. However, several changes were made to initiate, observe and score the response. The dimensions of both large and small objects were decreased to reflect sizes more easily held by the subjects. Trisection boundaries were designated on the table surface by pieces of masking tape for those subjects in chairs. Transfer credit for stereotypic behavior was eliminated by requiring that the object be retained for at least 2 seconds. The final change was made by increasing the number of intervals per trial to include the scoring of pretrial and posttrial transfer.

Subjects

The subjects for this study consisted of three handicapped children and a nonhandicapped infant. The handicapped subjects were chosen from

a severely/multiply handicapped classroom located in a university preschool. The normally developing infant was a younger sibling of another student at the preschool.

Subject 1. Danielle was a 5-year-old with mild spastic cerebral palsy and fine motor skills placing her at about a 9-month developmental level.

Subject 2. Mike was a hypotonic 4-year-old with fine motor skills placing him at about a 10-month developmental level.

Subject 3. David was a 4-year-old with spastic quadriplegia, blindness, hearing loss, seizure disorder and fine motor skills placing him at about a 9-month developmental level.

Subject 4. Greg was a normally developing 7-month-old who could reach, grasp, and release objects.

Procedures for Obtaining Measures of Reliability

Reliability measures were taken for each trial of every session by a second observer positioned so as to have an unobstructed view of the child's transfer response. The second observer was trained in use of the scoring notation and the definitions of the behaviors included in the scoring code.

The degree of reliability was determined by using the following formula:

$$\frac{\text{\# of agreements}}{\text{\# of agreements} + \text{\# of disagreements}}$$

For each trial, the total number of agreements was established by comparing the data for each examiner with the descriptor columns. The number of agreements was added to the number of disagreements to represent the total number possible. The percent of reliability was derived by dividing

the number of agreements by the number of agreements plus the number of disagreements and multiplying by 100.

Results

Measures of Interobserver Reliability

The interobserver reliability data for each subject are presented in Tables 1-10. Tables 1-5 present interobserver reliability data for behavior descriptors and trisection descriptors as a whole across each of the other variables, i.e., side of presentation, size of object, and time intervals. Tables 6-10 present interobserver reliability data for behavior descriptors calculated individually across size of presentation and size of object.

Subject 1 (Danielle). Interobserver reliability for behavior descriptors for small objects presented from the left ranged from 75%-87% across time intervals with a mean reliability of 82% (see Table 1). Interobserver reliability for trisection descriptors for small objects presented from the left ranged from 80%-95% across time intervals with a mean reliability of 89%. Row mean reliability for behavior and trisection descriptors for small objects presented from the left was 86%. Interobserver reliability for behavior descriptors presented for small objects presented from the right ranged from 58%-83% across time intervals with a mean reliability of 74%. Interobserver reliability for trisection descriptors for small objects presented from the right ranged from 83%-100% with a mean reliability of 89%. Row mean reliability for behavior and trisection descriptors for small objects presented from the right was 82%. Interobserver reliability for behavior descriptors for large objects presented from the left ranged from 77%-100% with a mean reliability of 88%. Interobserver reliability for trisection descriptors

Table 1

Interobserver Reliability Scores For
Behavior and Trisection Responses Across All Other Variables
For Subject 1 Based on 10 Sessions

Size	Side	Time	Behavior		Trisection		Mean Reliability
			Individual	Total	Individual	Total	
Small	Left	Pre	87		93		
		0-5	83	82	95	89	86
		5-10	75		80		
		Post	-		-		
	Right	Pre	83		83		
		0-5	81	74	83	89	82
		5-10	58		100		
		Post	-		-		
	Left	Pre	93		93		
		0-5	77	88	82	94	91
		5-10	80		100		
		Post	100		100		
Large	Right	Pre	80		100		
		0-5	81	79	97	99	89
		5-10	56		100		
		Post	100		100		
Mean Reliability			81		93	87	

Table 2

Interobserver Reliability Scores For
Behavior and Trisection Responses Across All Other Variables
For Subject 2 Based on 11 Sessions

Size	Side	Time	Behavior		Trisection		Mean Reliability
			Individual	Total	Individual	Total	
Small	Left	Pre	100		100		
		0-5	80	64	100	100	82
		5-10	75		100		
		Post	0		—		
	Right	Pre	91		70		
		0-5	62	68	93	88	78
		5-10	0		100		
		Post	—		—		
Large	Left	Pre	97		91		
		0-5	82	81	91	94	88
		5-10	63		100		
		Post	—		—		
	Right	Pre	91		76		
		0-5	82	89	83	80	85
		5-10	93		80		
		Post	—		—		
Mean Reliability			76		91	83	

Table 3

Interobserver Reliability Scores For
Behavior and Trisection Responses Across All Other Variables
For Subject 3 Based on 6 Sessions

Size	Side	Time	Behavior		Trisection		Mean Reliability
			Individual	Total	Individual	Total	
Small	Left	Pre	89		94		
		0-5	89	90	86	93	92
		5-10	92		100		
		Post	-		-		
	Right	Pre	66		100		
		0-5	78	77	100	100	89
		5-10	86		100		
		Post	-		-		
Large	Left	Pre	100		94		
		0-5	83	83	80	91	87
		5-10	66		100		
		Post	-		-		
	Right	Pre	83		100		
		0-5	83	89	100	98	94
		5-10	100		94		
		Post	-		-		
Mean Reliability			85		96	90	

Table 4

Interobserver Reliability Scores For
Behavior and Trisection Responses Across All Other Variables
For Subject 4 Based on 7 Sessions

Size	Side	Time	Behavior		Trisection		Mean Reliability
			Individual	Total	Individual	Total	
Small	Left	Pre	90		95		
		0-5	74	88	100	98	93
		5-10	100		100		
		Post	-		-		
	Right	Pre	85		91		
		0-5	83	61	81	85	73
		5-10	75		83		
		Post	0		-		
Large	Left	Pre	81		90		
		0-5	71	62	100	97	79
		5-10	33		100		
		Post	-		-		
	Right	Pre	62		100		
		0-5	95	80	95	93	87
		5-10	83		83		
		Post	-		-		
Mean Reliability			73		93	83	

Table 5

Interobserver Reliability Scores For
Behavior and Trisection Responses Across All Other Variables
For All Subjects

Size	Side	Time	Behavior		Trisection		Mean Reliability
			Individual	Total	Individual	Total	
Small	Left	Pre	94		96		
		0-5	81	65	95	95	80
		5-10	86		95		
		Post	0		-		
	Right	Pre	81		86		
		0-5	76	71	89	90	80
		5-10	55		96		
		Post	-		-		
Large	Left	Pre	92		92		
		0-5	78	85	88	95	90
		5-10	61		100		
		Post	100		100		
	Right	Pre	77		94		
		0-5	85	88	94	94	90
		5-10	83		89		
		Post	100		100		
Mean Reliability			74		93	88	

Table 6
Interobserver Reliability Scores For
Behavior and Trisection Responses Calculated Individually
For Subject 1 Based on 10 Sessions

Descriptor	Small		Large		Mean Reliability
	Left	Right	Left	Right	
Transfer	93	88	92	80	88
Transfer w/ 3rd Surface	-	50	63	67	60
Both Hands	95	94	97	94	95
Mouth	04	57	-	33	31
Hand	55	86	100	40	70
Drop	100	100	100	100	100
Cross	100	-	100	-	100
Trisection 1	100	83	-	83	89
Trisection 2	92	90	100	100	96
Trisection 3	100	-	100	-	100
Mean Reliability	82	81	94	75	

Table 7
Interobserver Reliability Scores For
Behavior and Trisection Responses Calculated Individually
For Subject 2 Based on 11 Sessions

Descriptor	Small		Large		Mean Reliability
	Left	Right	Left	Right	
Transfer	50	61	-	-	56
Transfer w/ 3rd Surface	83	85	100	100	92
Both Hands	100	96	96	97	97
Mouth	-	-	100	-	100
Hand	100	66	44	80	73
Drop	100	50	75	75	75
Cross	100	100	-	100	100
Trisection 1	-	63	-	68	66
Trisection 2	100	86	98	91	94
Trisection 3	100	0	33	0	33
Mean Reliability	92	67	78	76	

Table 8

Interobserver Reliability Scores for
Behavior and Trisection Responses Calculated Individually
For Subject 2 Based on 6 Sessions

Descriptor	Small		Large		Mean Reliability
	Left	Right	Left	Right	
Transfer	33	0	-	100	44
Transfer w/ 3rd Surface	100	100	100	50	88
Both Hands	100	94	100	88	96
Mouth	100	55	100	100	89
Hand	0	100	100	100	75
Drop	100	100	92	88	95
Cross	100	-	-	-	100
Trisection 1	100	-	0	100	67
Trisection 2	98	100	88	97	96
Trisection 3	0	100	100	100	75
Mean Reliability	73	81	85	93	

Table 9
Interobserver Reliability Scores For
Behavior and Trisection Responses Calculated Individually
For Subject 4 Based on 7 Sessions

Descriptor	Small		Large		Mean Reliability
	Left	Right	Left	Right	
Transfer	90	100	80	-	90
Transfer w/ 3rd Surface	63	80	77	100	80
Both Hands	100	86	95	95	94
Mouth	-	66	50	33	50
Hand	66	100	66	100	83
Drop	100	100	100	100	100
Cross	100	-	-	-	100
Trisection 1	100	100	0	100	75
Trisection 2	100	90	100	94	96
Trisection 3	100	-	33	100	78
Mean Reliability	92	81	66	91	

Table 10

Interobserver Reliability Scores For
Behavior and Trisection Responses Calculated Individually
Across All Subjects

Descriptor	Small		Large		Mean Reliability
	Left	Right	Left	Right	
Transfer	67	62	86	90	76
Transfer w/ 3rd Surface	62	82	85	79	77
Both Hands	99	94	97	85	94
Mouth	52	63	83	55	63
Hand	55	88	78	80	63
Drop	100	88	92	91	93
Cross	100	100	100	100	100
Trisection 1	100	82	0	88	68
Trisection 2	98	92	97	96	96
Trisection 3	75	50	67	66	65
Mean Reliability	81	80	79	83	

for large objects presented from the left ranged from 82%-100% with a mean reliability of 94%. Row mean reliability for behavior and trisection descriptors for large objects presented from the left was 91%. Interobserver reliability for behavior descriptors for large objects presented to the right across time intervals ranged from 56%-100% with a mean reliability of 79%. Interobserver reliability for trisection descriptors for large objects presented from the right across time intervals ranged from 97%-100% with a mean reliability of 99%. Row mean reliability for behavior and trisection descriptors for large objects presented from the right was 89%. Column mean reliability for behavior descriptors across sizes, positions, and intervals was 81%. Column mean reliability for trisection descriptors across sizes, positions and intervals was 93%. Grand mean interobserver reliability was 87%.

Interobserver reliability for individual behavior and trisection descriptors is represented in Table 6. Reliability for transfer responses ranged from 80%-93%. Mean reliability for transfer responses was 88%. Interobserver reliability for transfer with a third surface responses ranged from 50%-67%. Mean reliability for transfer with a third surface responses was 60%. Interobserver reliability for both hands responses ranged from 94%-97%. Mean reliability for both hands responses was 95%. Interobserver reliability for mouthing response ranged from 4%-57% with a mean reliability of 31%. Interobserver reliability for one hand responses ranged from 40%-100% with a mean reliability of 70%. Mean interobserver reliability for drop responses was 100%. Mean interobserver reliability for cross responses was 100%. Interobserver reliability responses for trisection (1) responses ranged from 83%-100% with a mean reliability of 89%. Interobserver reliability for trisection (2) responses

ranged from 90%-100% with a mean interobserver reliability of 96%. Mean interobserver reliability for trisection (3) responses was 100%.

Subject 2 (Mike). Interobserver reliability for behavior descriptors for small objects presented from the left ranged from 0%-100% across time intervals with a mean reliability of 64% (see Table 2). Mean interobserver reliability for trisection descriptors for small objects presented from the left was 100%. Row mean reliability for behavior and trisection descriptors for small objects presented from the left was 82%. Interobserver reliability for behavior descriptors for small objects presented from the right ranged from 0-91% with a mean reliability of 68%. Interobserver reliability for trisection descriptors for small objects presented from the right ranged from 70-100% with a mean reliability of 88%. Row mean reliability for behavior and trisection descriptors for small objects presented from the right was 78%. Interobserver reliability for behavior descriptors for large objects presented from the left ranged from 63-97% with a mean reliability of 81%. Interobserver reliability for trisection descriptors for large objects presented from the left ranged from 91-100% with a mean reliability of 94%. Row mean reliability for behavior and trisection descriptors for large objects presented from the left was 88%. Interobserver reliability for behavior descriptors for large objects presented from the right ranged from 76-83% with a mean reliability of 80%. Row mean reliability for behavior and trisection descriptors for large objects presented from the right was 85%. Column mean reliability for behavior descriptors presented across sizes, positions, and intervals was 76%. Column mean reliability for trisection descriptors presented across sizes, positions and intervals was 91%. Grand mean interobserver reliability was 83%.

Interobserver reliability for individual behavior and trisection is represented in Table 7. Reliability for transfer responses ranged from 50-61% with a mean of 56%. Interobserver reliability for transfer with a third surface responses ranged from 83-100% with a mean reliability of 92%. Interobserver reliability for both hands responses ranged from 96-100% with a mean reliability of 97%. Mean interobserver reliability for mouthing responses was 100%. Interobserver reliability for one hand responses ranged from 44-100% with a mean reliability of 73%. Interobserver reliability for drip response ranged from 50-100% with a mean reliability of 75%. Mean interobserver reliability for cross responses was 100%. Interobserver reliability for trisection (1) responses ranged from 63-68% with a mean reliability of 66%. Interobserver reliability for trisection (2) responses ranged from 86-100% with a mean reliability of 94%. Interobserver reliability for trisection (3) responses ranged from 0-100% with a mean reliability of 33%.

Subject 3 (David). Interobserver reliability for behavior descriptors for small objects presented from the left ranged from 89-92% with a mean reliability of 90%. Interobserver reliability for trisection descriptors for small objects presented from the left ranged from 86-100% with a mean reliability of 93%. Row mean reliability for behavior and trisection descriptors for small objects presented from the left was 92%. Interobserver reliability for behavior descriptors for small objects presented from the right ranged from 66-86% with a mean reliability of 77%. Mean interobserver reliability for trisection descriptors for small objects presented from the right was 100%. Row mean reliability for behavior and trisection descriptors for small objects presented from the right was 89%. Interobserver reliability for behavior descriptors

for large objects presented from the left ranged from 66-100% with a mean reliability of 91%. Row mean reliability for behavior and trisection descriptors for large objects presented from the left ranged from 80-100% with a mean reliability of 91%. Row mean reliability for behavior and trisection descriptors for large objects presented from the left was 87%. Interobserver reliability for behavior descriptors for large objects presented from the right ranged from 83-100% with a mean reliability of 89%. Interobserver reliability for trisection descriptors for large objects presented from the right ranged from 94-100% with a mean reliability of 98%. Row mean reliability for behavior and trisection descriptors for large objects presented from the right was 94%. Column mean reliability for behavior descriptors presented across sizes, positions and intervals was 85%. Column mean reliability for trisections presented across sizes, positions and intervals was 96%. Grand mean interobserver reliability was 90%.

Interobserver reliability for individual behavior and trisection descriptors is represented in Table 8. Reliability for transfer responses ranged from 0-100% with a mean reliability of 44%. Interobserver reliability for transfer with a third surface reliability for both hands responses ranged from 88-100% with a mean reliability of 96%. Interobserver reliability for mouthing responses ranged from 55-100% with a mean reliability of 89%. Mean interobserver reliability for one hand response was 100%. Interobserver reliability for drop responses ranged from 88-100% with a mean reliability of 95%. Mean interobserver reliability for cross responses was 100%. Interobserver reliability for trisection (1) responses ranged from 0-100% with a mean reliability of 67%. Interobserver reliability for trisection (2) responses ranged from 88-100%

with a mean reliability of 96%. Interobserver reliability for trisection (3) responses ranged from 0-100% with a mean reliability of 75%.

Subject 4 (Greg). Interobserver reliability for behavior descriptors for small objects presented from the left ranged from 74-100 with a mean reliability of 88% (see Table 4). Interobserver reliability for trisection descriptors for small objects presented from the left ranged from 95-100%. Row mean reliability for behavior and trisection descriptors for small objects presented from the left was 93%. Interobserver reliability for behavior descriptors for small objects presented from the right ranged from 0-85% with a mean reliability of 61%. Interobserver reliability for trisection descriptors for small objects presented from the right ranged from 81-91% with a mean reliability of 85%. Row mean reliability for behavior and trisection descriptors for small objects presented from the right was 73%. Interobserver reliability for behavior descriptors for large objects presented from the left ranged from 33-81% with a mean reliability of 62%. Interobserver reliability for trisection descriptors for large objects presented from the left was 79%. Interobserver reliability for behavior descriptors for large objects presented from the left ranged from 62-95% with a mean reliability of 93%. Row mean reliability for behavior and trisection descriptors for large objects presented from the right was 87%. Column mean reliability for behavior descriptors presented across sizes, positions and intervals was 73%. Column mean reliability for trisection descriptors presented across all sizes, positions and intervals was 93%. Grand mean interobserver reliability was 83%.

Interobserver reliability for individual behavior and trisection descriptors is presented in Table 9. Reliability for transfer responses

↑

ranged from 80-100% with a mean reliability of 90%. Interobserver reliability for transfer with a third surface responses ranged from 63-100% with a mean reliability of 90%. Interobserver reliability for both hands responses ranged from 86-100% with a mean reliability of 94%. Interobserver reliability for mouthing responses ranged from 33-66% with a mean reliability of 66%. Interobserver reliability for one hand responses ranged from 66-100% with a mean reliability of 83%. Mean interobserver reliability for drop responses was 100%. Mean interobserver reliability for across responses was 100%. Interobserver reliability for trisection (1) responses ranged from 0-100% with a mean reliability of 75%. Interobserver reliability for trisection (2) responses ranged from 90-100% with a mean reliability of 96%. Interobserver reliability for trisection (3) responses ranged from 33-100% with a mean reliability of 78%.

Overall Interobserver Reliability. A summary of interobserver reliability data for all subjects is presented in Tables 5 and 10. Interobserver reliability for behavior descriptors for small objects presented from left ranged from 0-91% with a mean reliability of 65%. Interobserver reliability for trisection descriptors for small objects presented from the left ranged from 95-96% with a mean of 95%. Row mean reliability from the left was 80%. Interobserver reliability for behavior descriptors for small objects presented from the right ranged from 55-81% with a mean reliability of 71%. Interobserver reliability for trisection descriptors for small objects presented from the right ranged from 86-96% with a mean reliability of 90%. Row mean reliability for behavior and trisection descriptors for small objects presented from the right was 80%. Interobserver reliability for behavior descriptors for

large objects presented from the left ranged from 61-100% with a mean reliability of 85%. Interobserver reliability for trisection descriptors for large objects presented from the left ranged from 88-100% with a mean reliability of 95%. Row mean reliability for behavior and trisection descriptors for large objects presented from the left was 90%. Interobserver reliability for behavior descriptors for large objects presented from the right ranged from 77-100% with a mean reliability of 86%. Interobserver reliability for trisection descriptors for large objects presented from the right ranged from 89-100% with a mean reliability of 94%. Row mean reliability for behavior and trisection descriptors for large objects presented from the right was 90%. Column mean reliability for behavior descriptors across sizes, positions and intervals was 74%. Column mean reliability for trisection descriptors across sizes, positions and intervals was 93%. Grand mean interobserver reliability was 88%.

Interobserver reliability for individual behavior and trisection descriptors is presented in Table 10. Reliability for transfer responses ranged from 62-90% with a mean reliability of 76%. Interobserver reliability for transfer with a third surface responses ranged from 62-85% with a mean of 77%. Interobserver reliability for both hands responses ranged from 85-99% with a mean reliability of 94%. Interobserver reliability for mouthing responses ranged from 52-83% with a mean reliability of 63%. Interobserver reliability for one hand responses ranged from 55-88% with a mean reliability of 63%. Interobserver reliability for drop responses ranged from 88-100% with a mean reliability of 93%. Mean interobserver reliability for cross responses was 100%. Interobserver reliability for trisection (1) responses ranged from 0-100% with a mean reliability of 68%. Interobserver reliability for trisection (2) responses

ranged from 92-96% with a mean reliability of 96%. Interobserver reliability for trisection (3) responses ranged from 50-75% with a mean reliability of 65%.

Performance Measures

The performance data for each subject are contained on the graphs of Figures 1-16. Each figure contains seven graphs, one for each behavior descriptor (e.g., transfer). The numbers on the abscissa of each graph represent the sessions. The ordinate of each graph represents 0-100% performance of a given variable. The symbols and connecting lines are labeled at the bottom of each figure. Figures 1-4 present the performance of each behavior as a percent of all responses made with large objects for each session. Figures 1-4 also present the performance of each behavior as a percent of all responses made with small objects for each session. Figures 5-8 present the performance of each behavior for all responses made to objects presented from the left for each session. Figures 5-8 also present the performance of each behavior as a percent of all responses made to objects presented from the right for each session. Figures 9-12 show the percent of each behavior which occurred in each time interval for each session. Figures 13-16 show the percent of each behavior which occurred in each trisection for each session.

Subject 1 (Danielle). Performance data are shown for 10 sessions. Data for large and small objects is represented in Figure 1. This figure illustrated overall increasing trend in transfer responses with a greater increase in the percent of transfers made with small objects. There is some fluctuating in the other responses, but overall there is a consistent number of transfer with third surface, one hand and mouthing

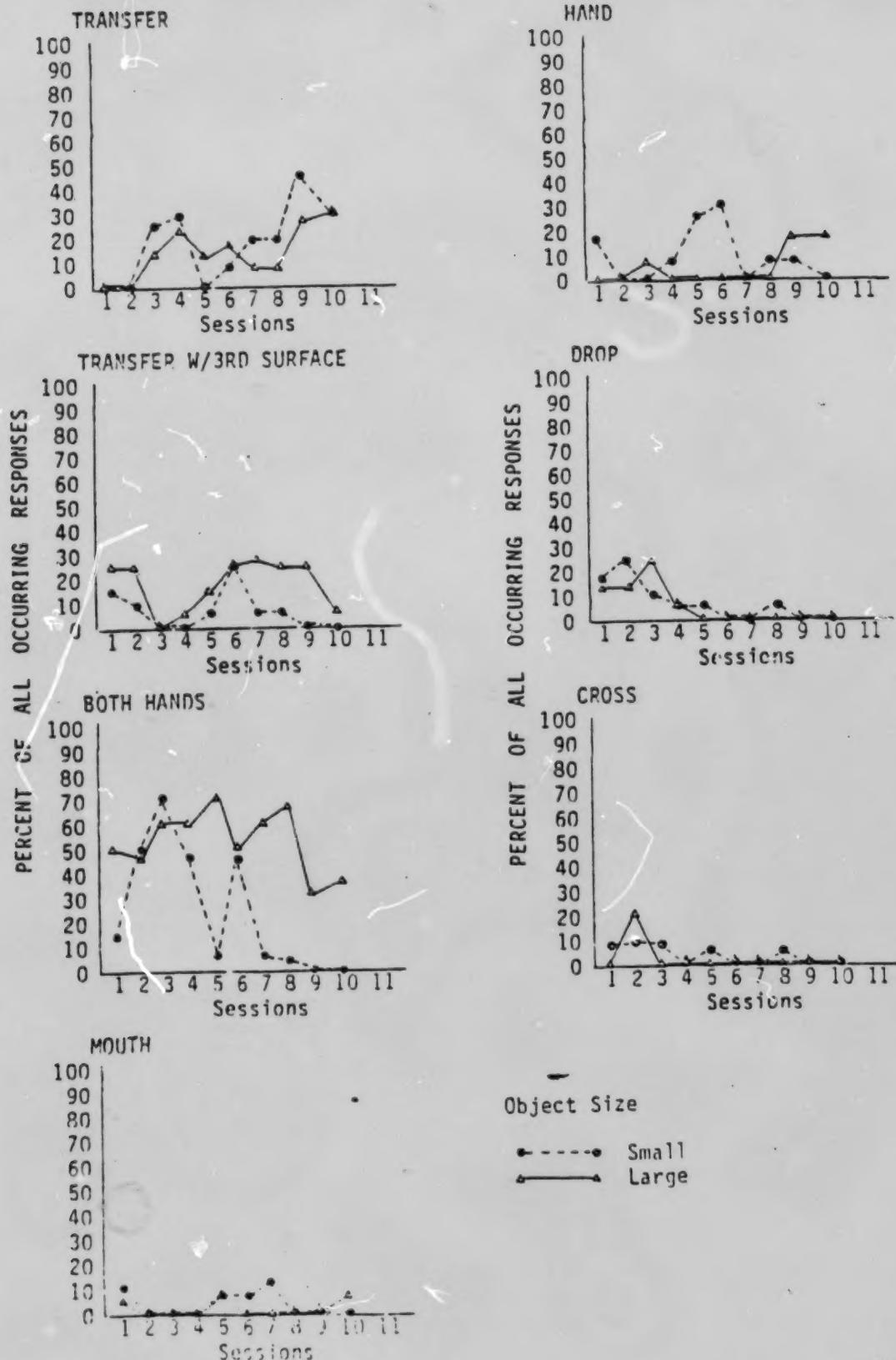


Figure 1. A comparison of responses made by Subject 1 to large and small objects.

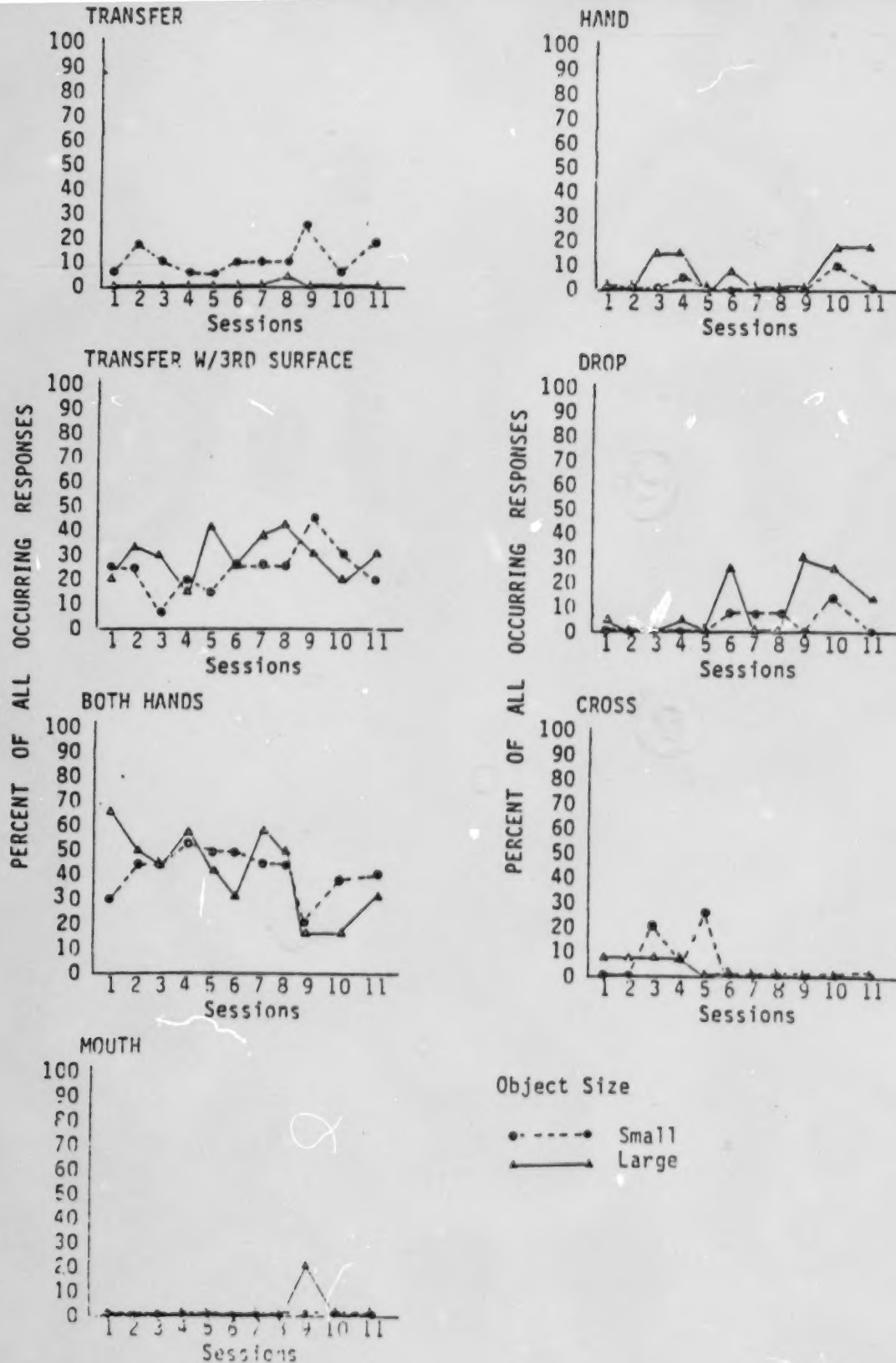


Figure 2. A comparison of responses made by Subject 2 to large and small objects.

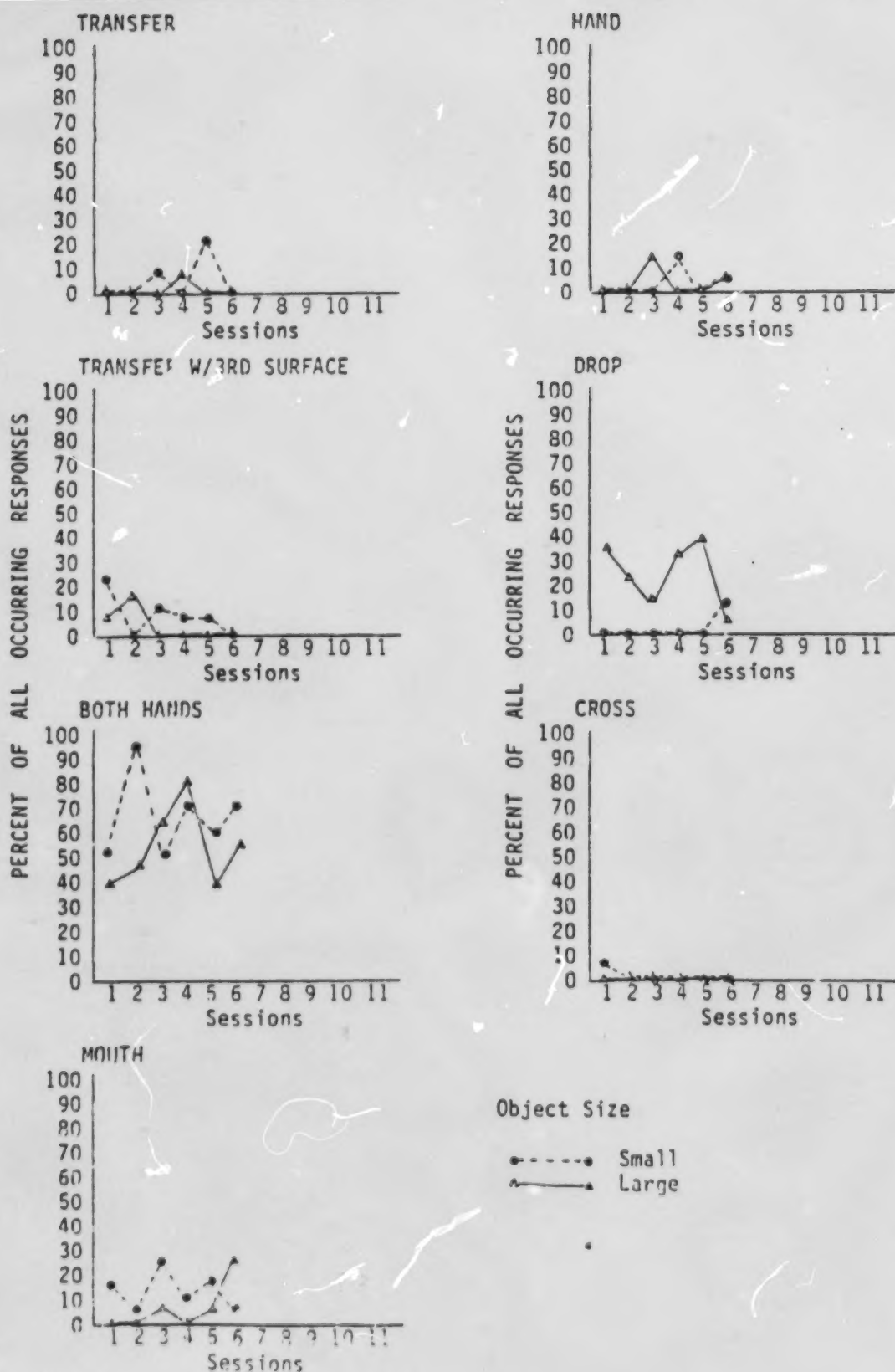


Figure 3. A comparison of responses made by Subject 3 to large and small objects.

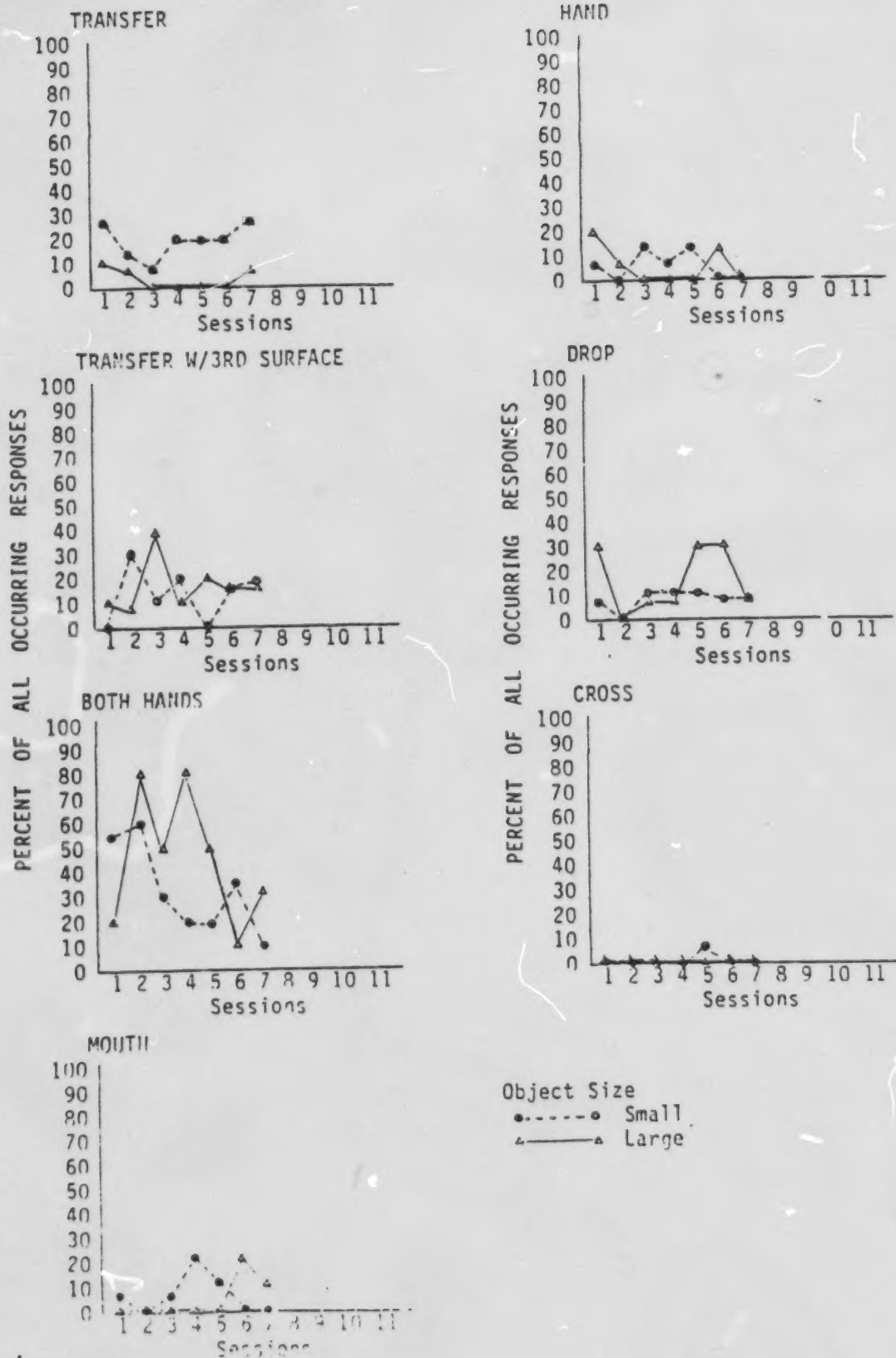


Figure 4. A comparison of responses made by Subject 4 to large and small objects.

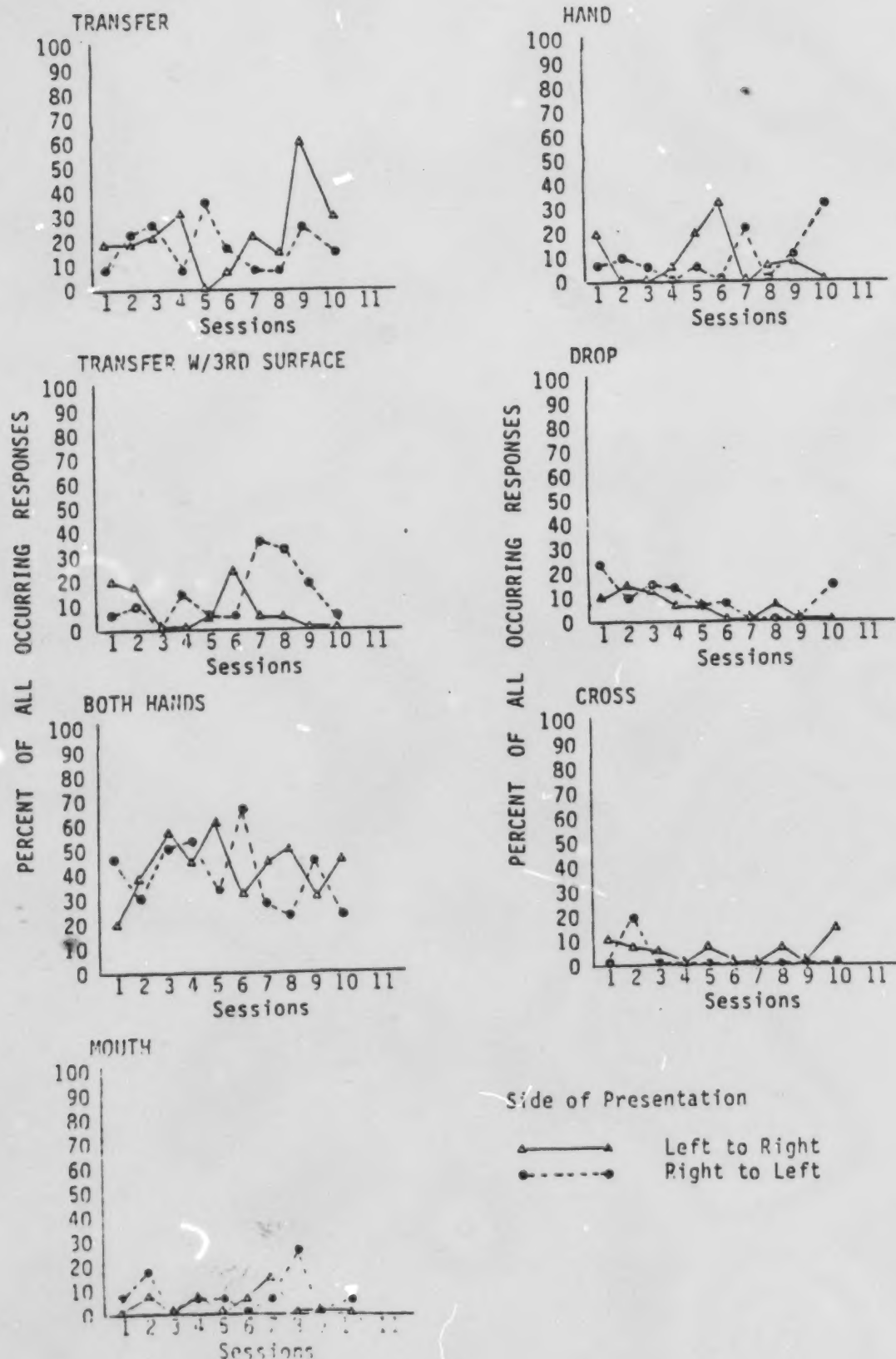


Figure 5. A comparison of responses made by Subject 1 to presentation of objects to left and right sides.

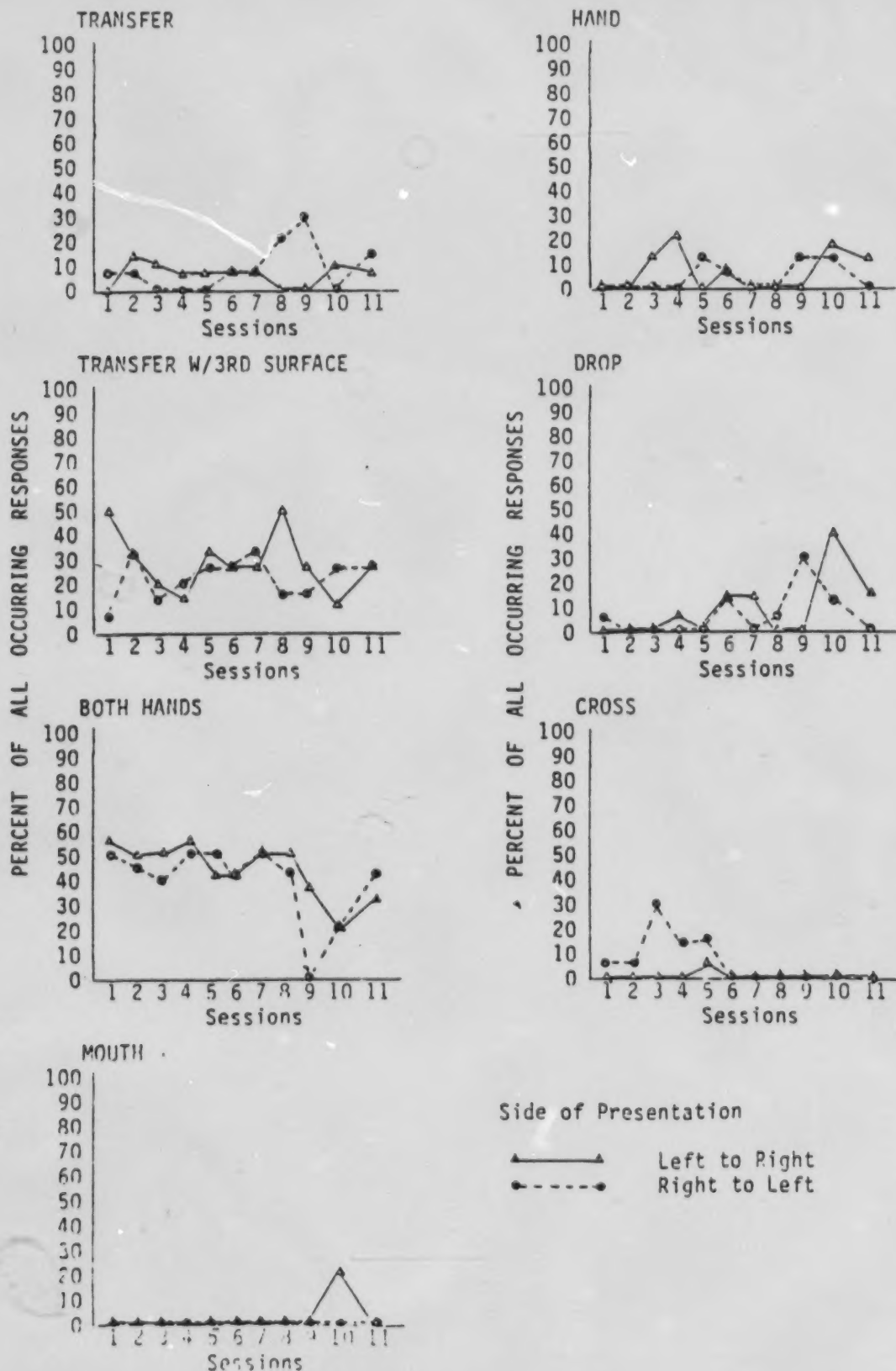


Figure 6. A comparison of responses made by Subject 2 to presentation of objects to left and right sides.

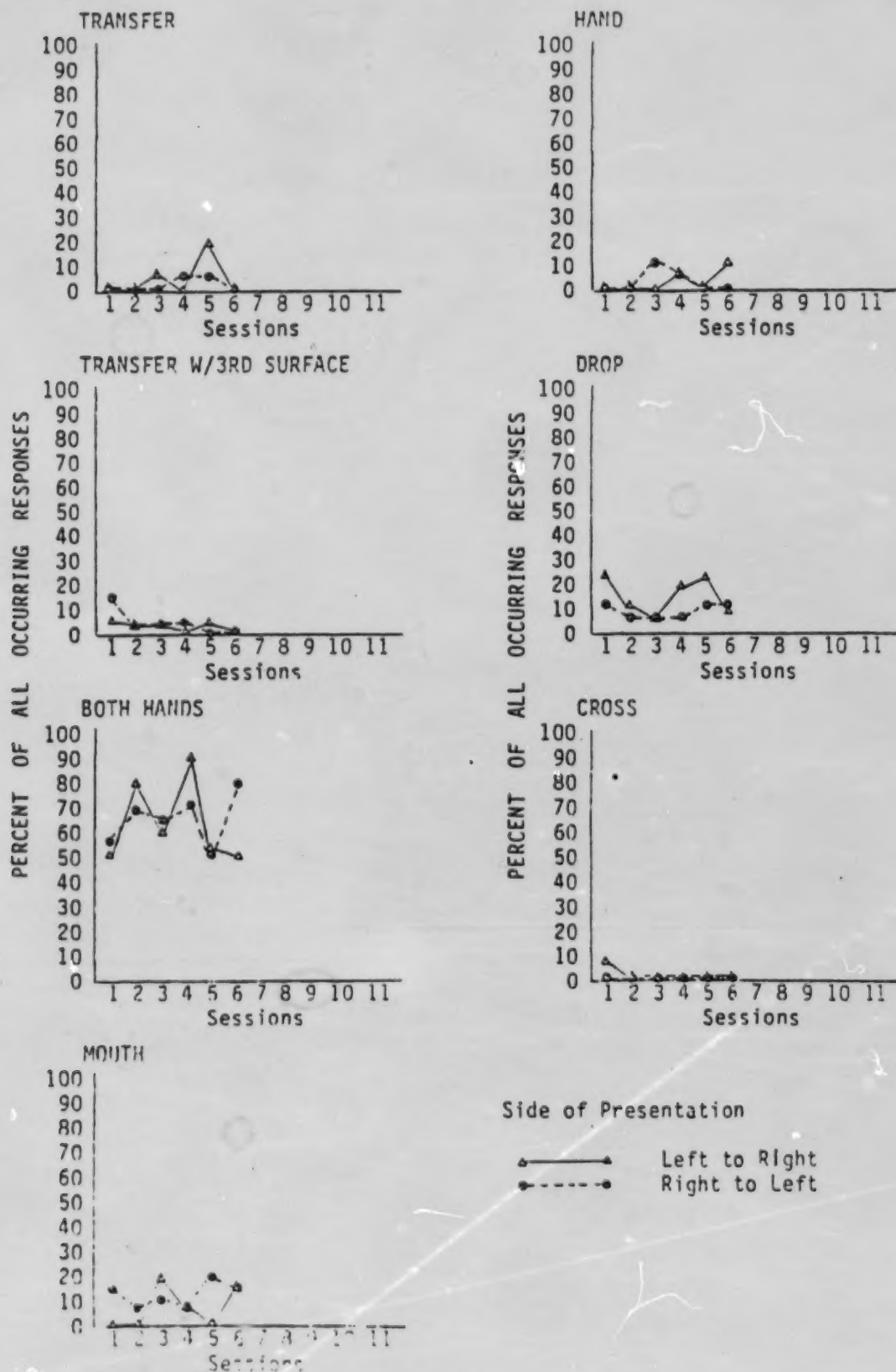


Figure 7. A comparison of responses made by Subject 3 to presentation of objects to left and right sides. 217

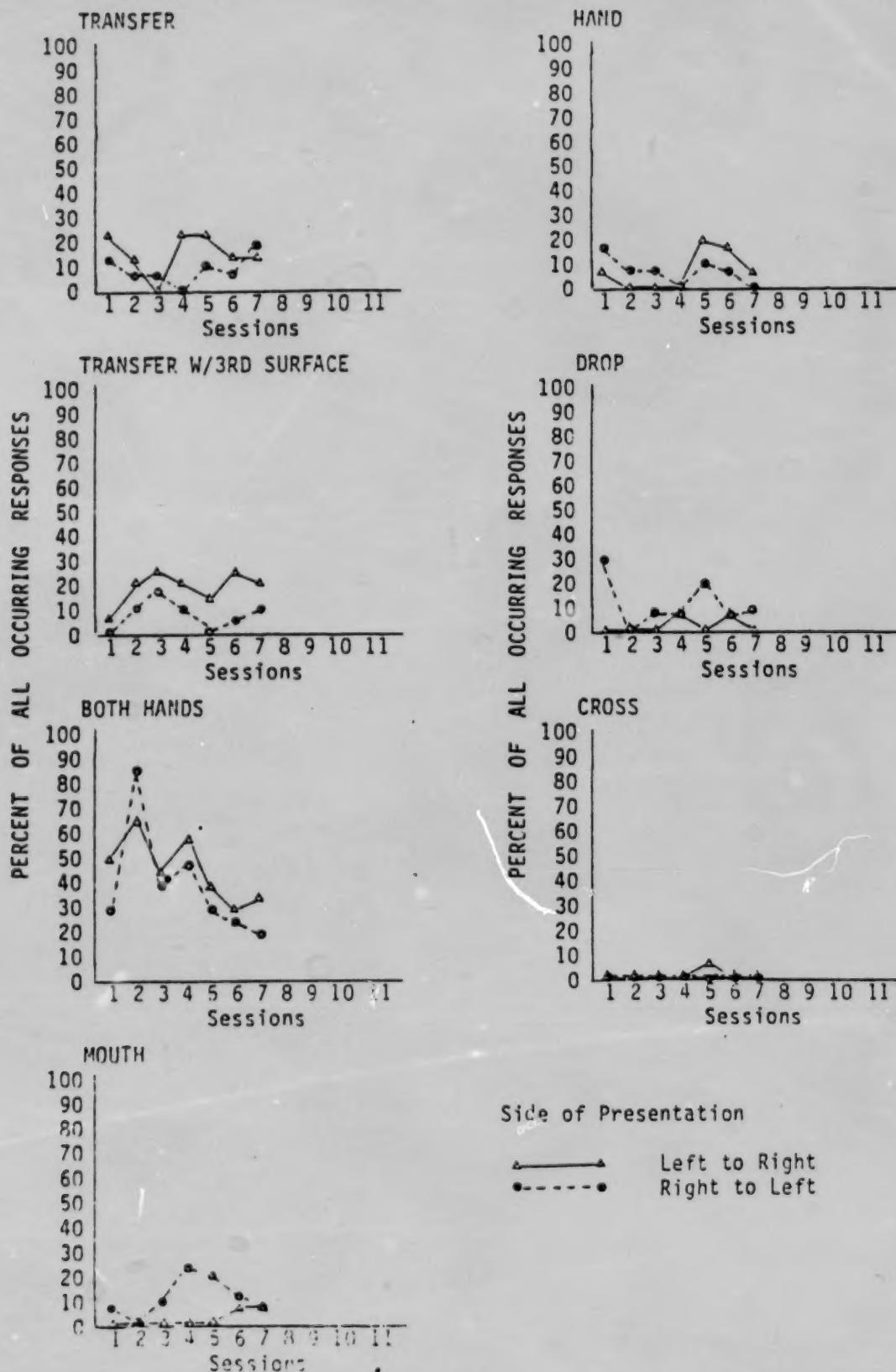


Figure 8. A comparison of responses made by Subject 4 to presentation of objects to left and right sides.

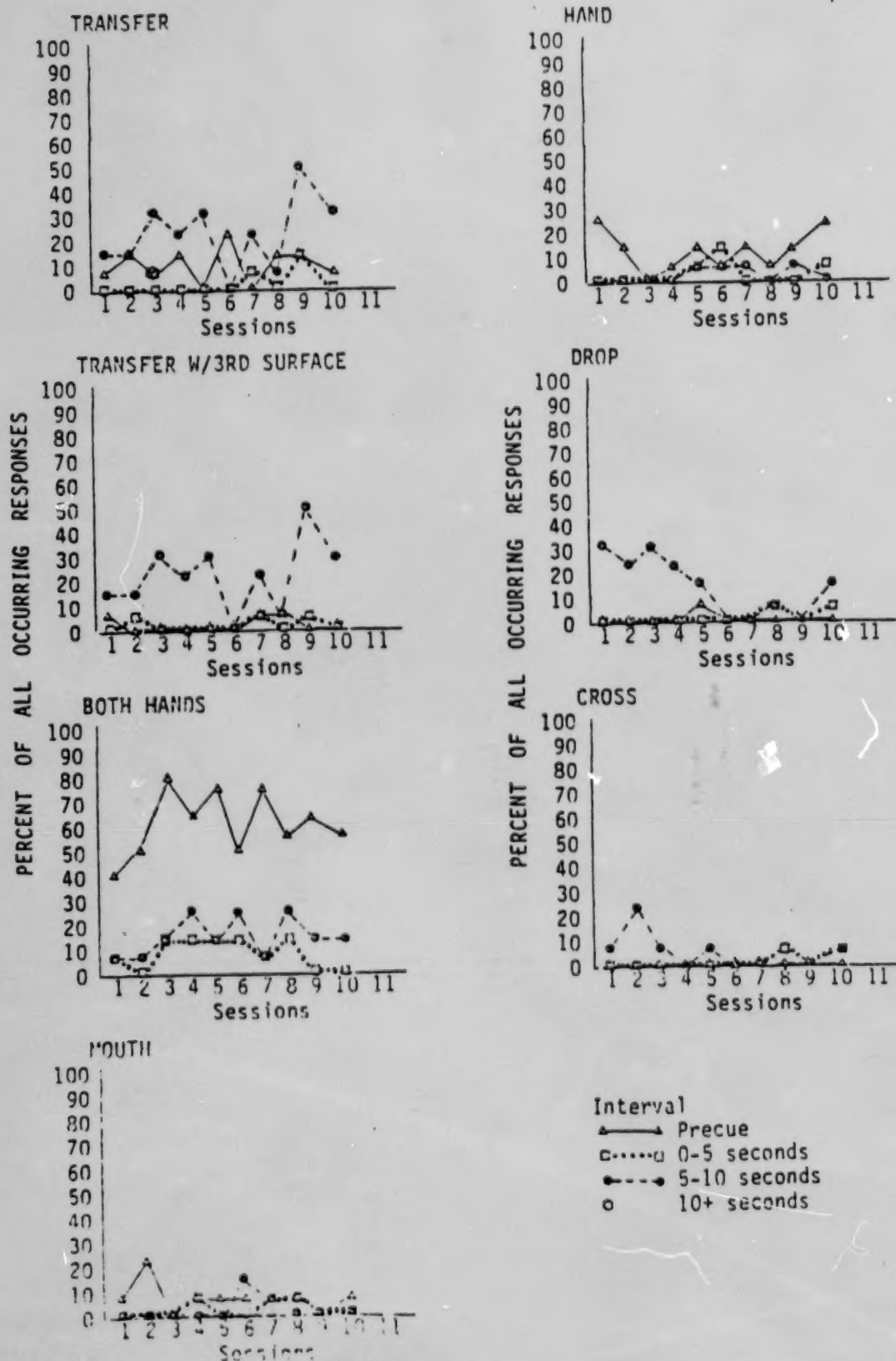


Figure 9. A comparison of responses made by Subject 1 in each time interval.

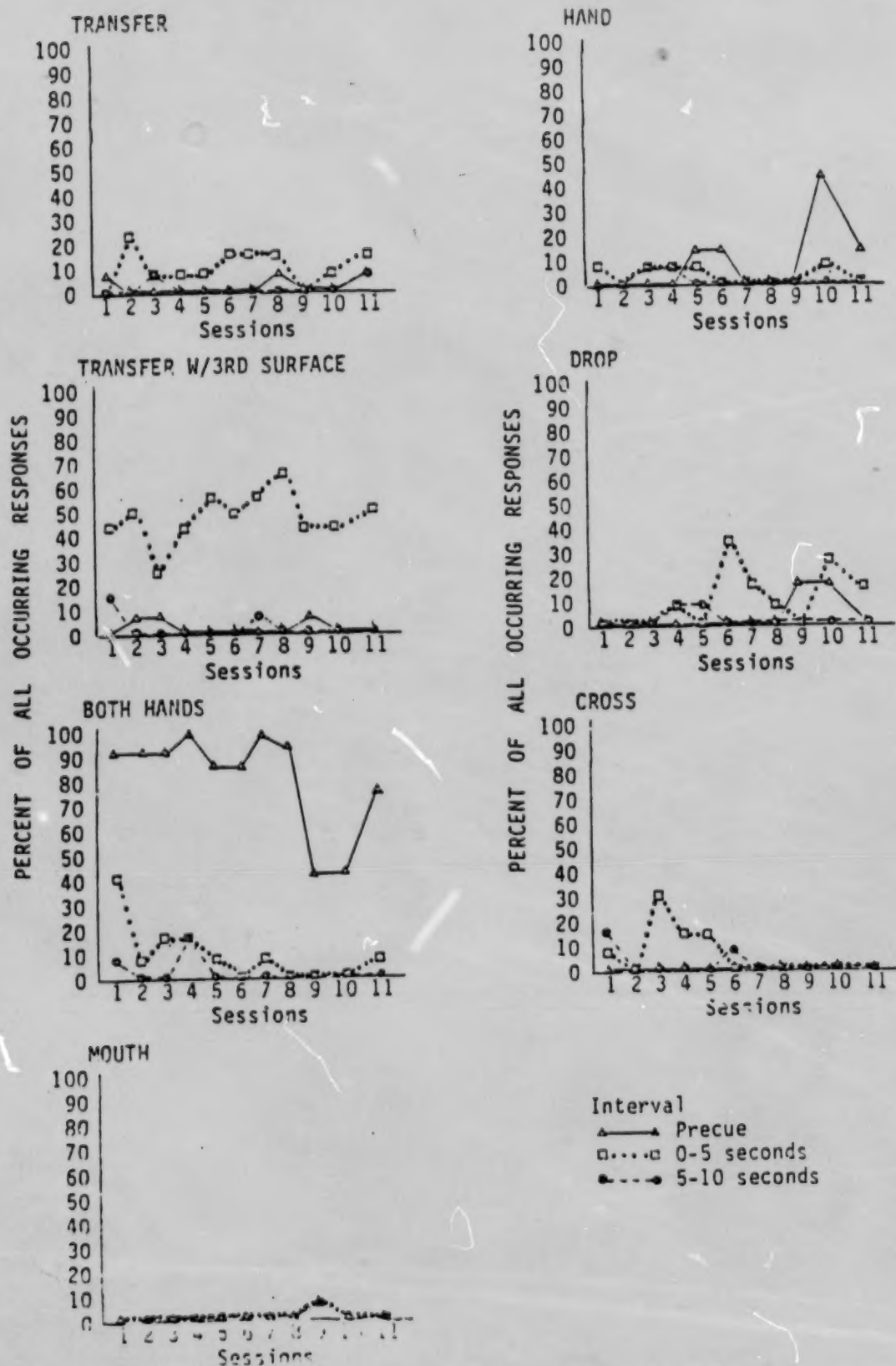


Figure 10. A comparison of responses made by Subject 2 in each time interval.

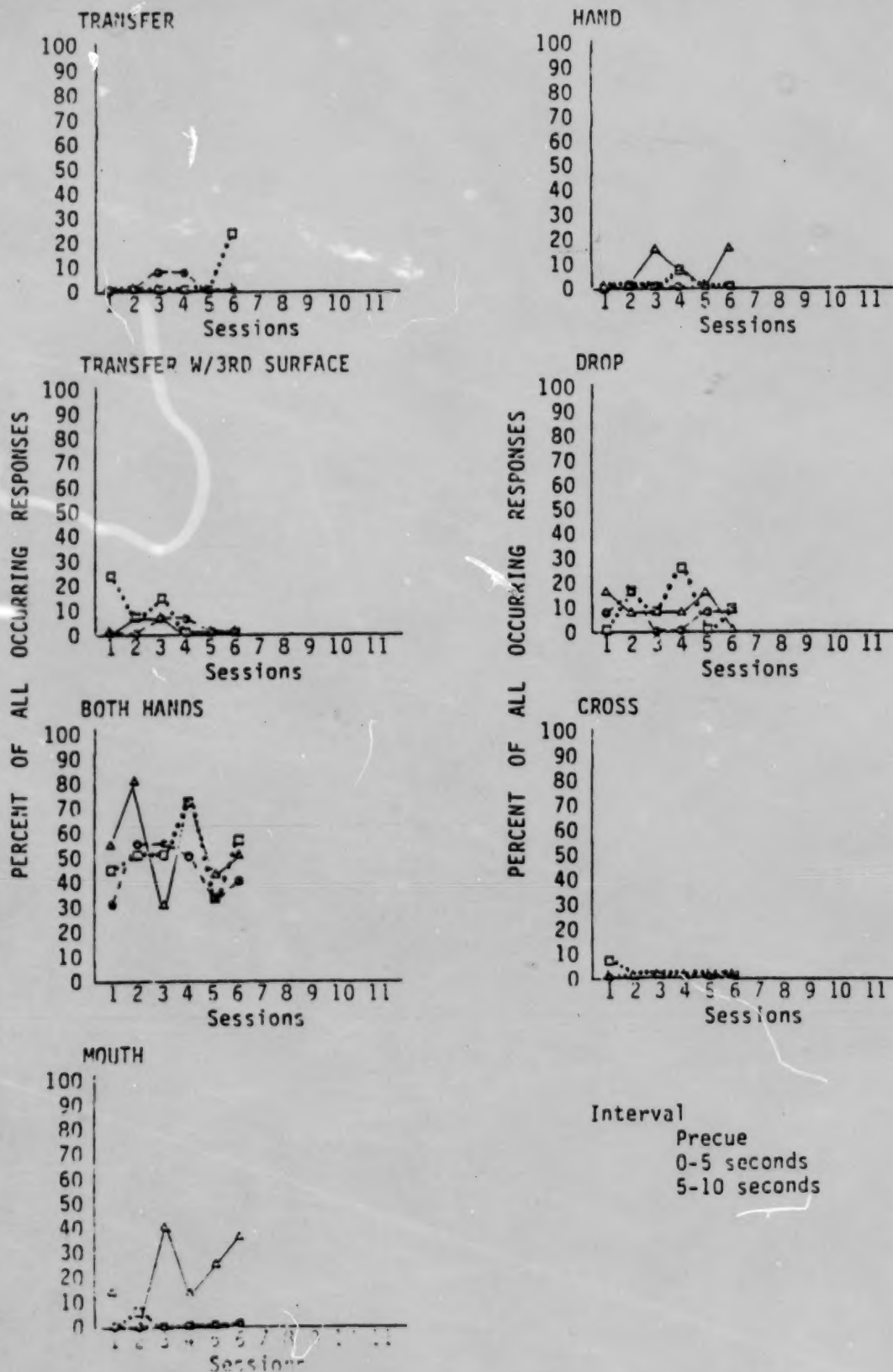


Figure 11. A comparison of responses made by Subject 3 in each time interval.

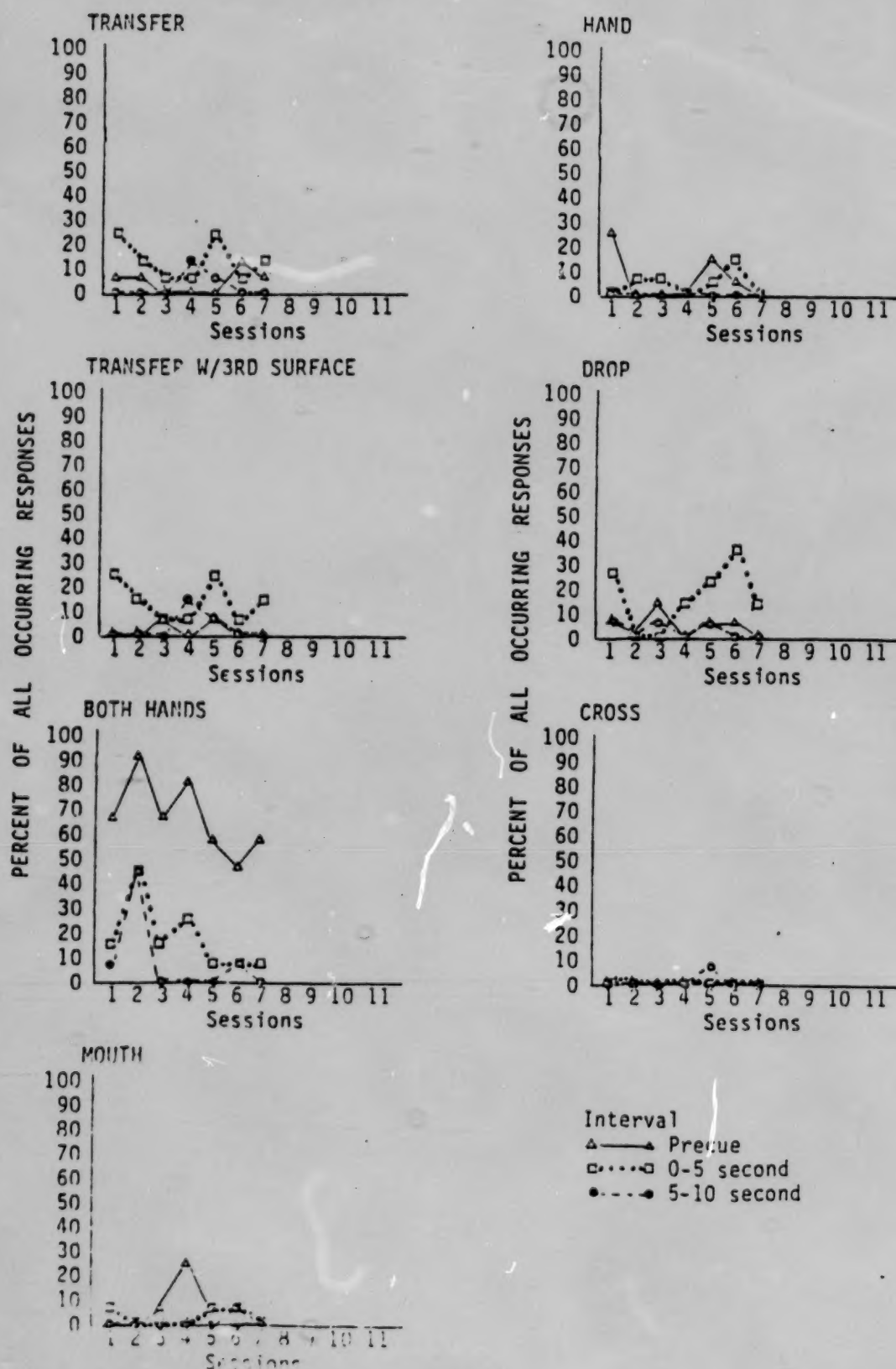


Figure 12. A comparison of responses made by Subject 4 in each time interval.

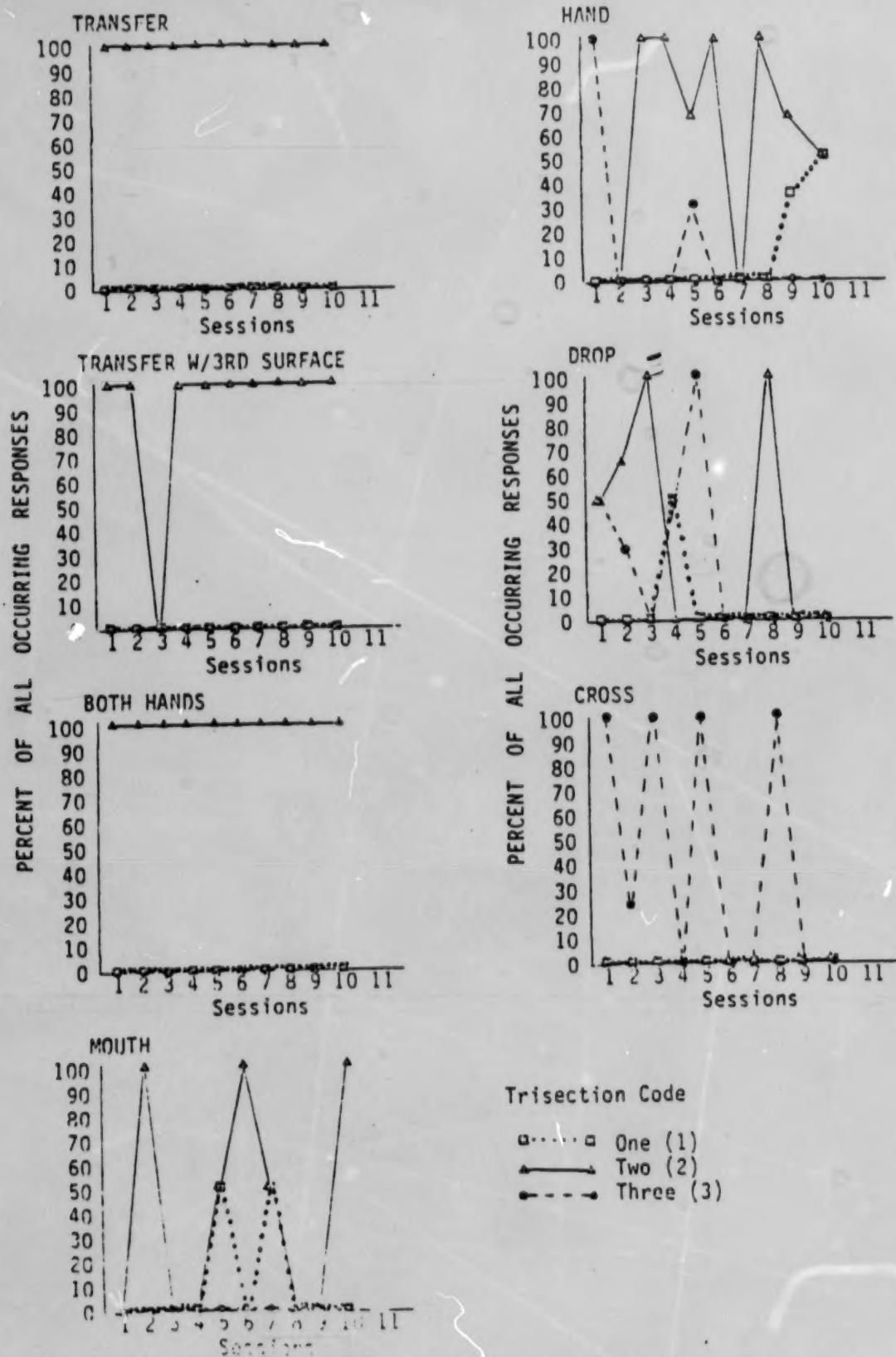


Figure 13. A comparison of responses made by Subject 1 in each

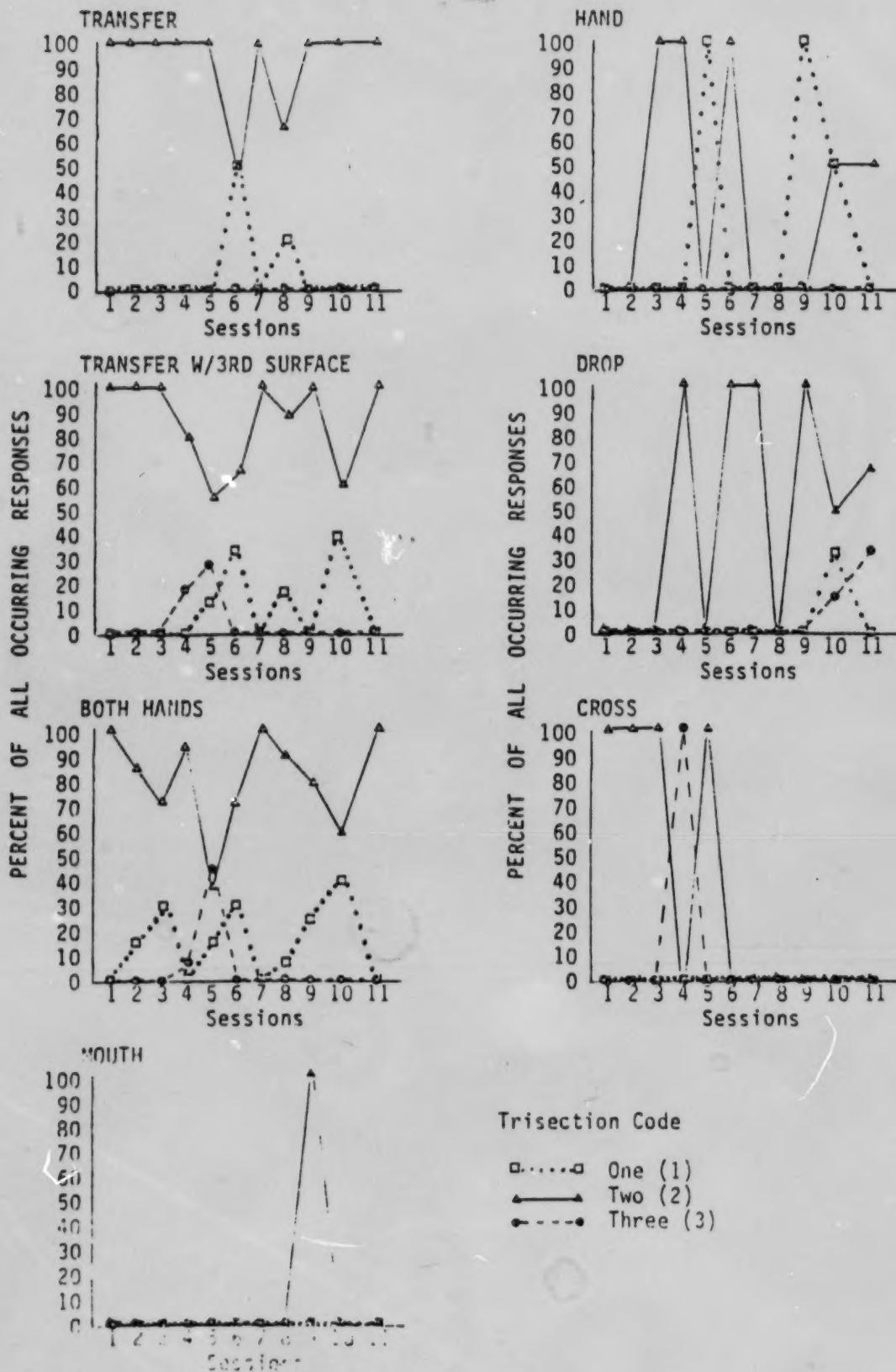


Figure 14. A comparison of responses made by Subject 2 in each trisection.

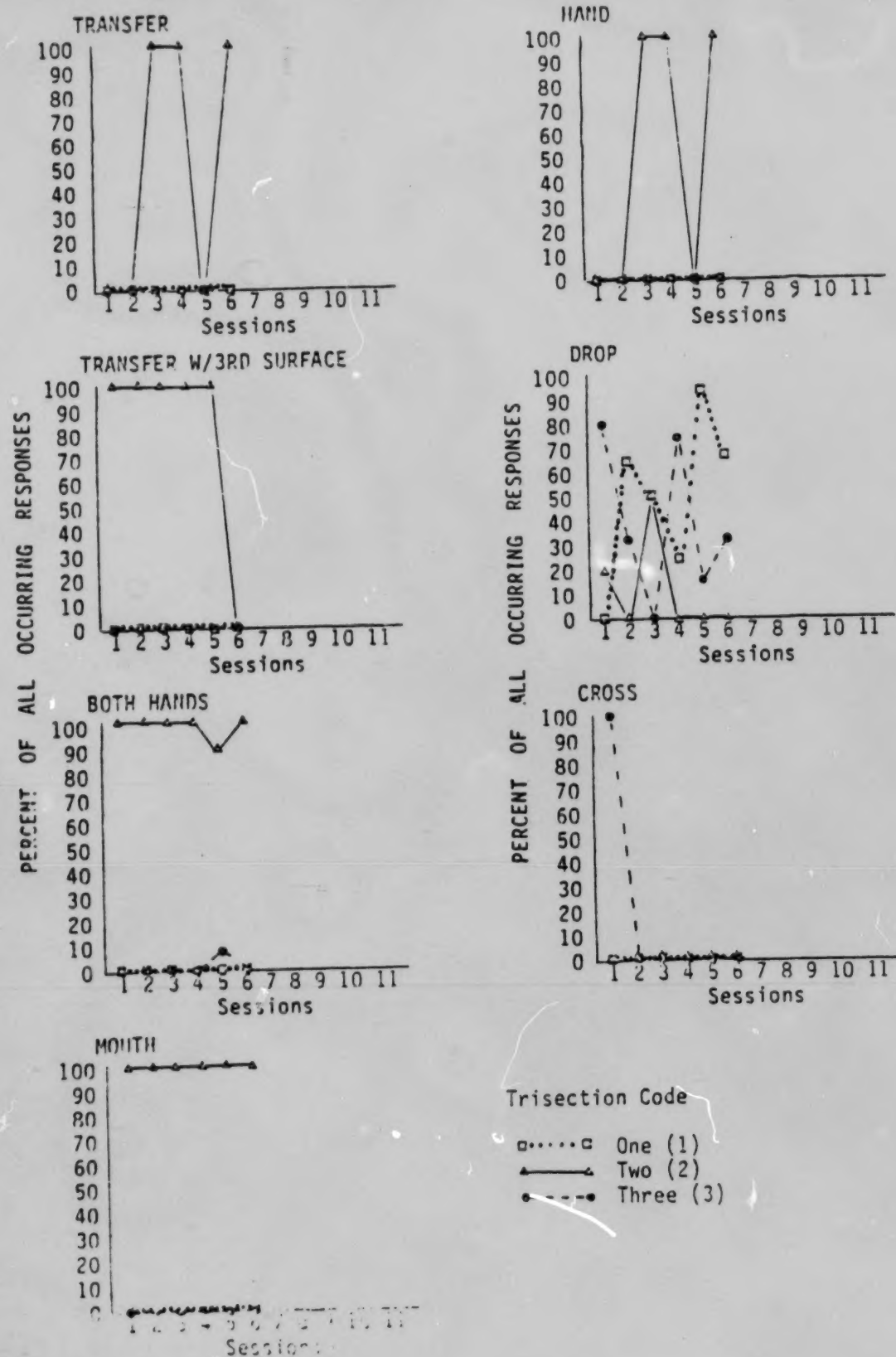


Figure 15. A comparison of responses made by Subject 3 in each

trisection.

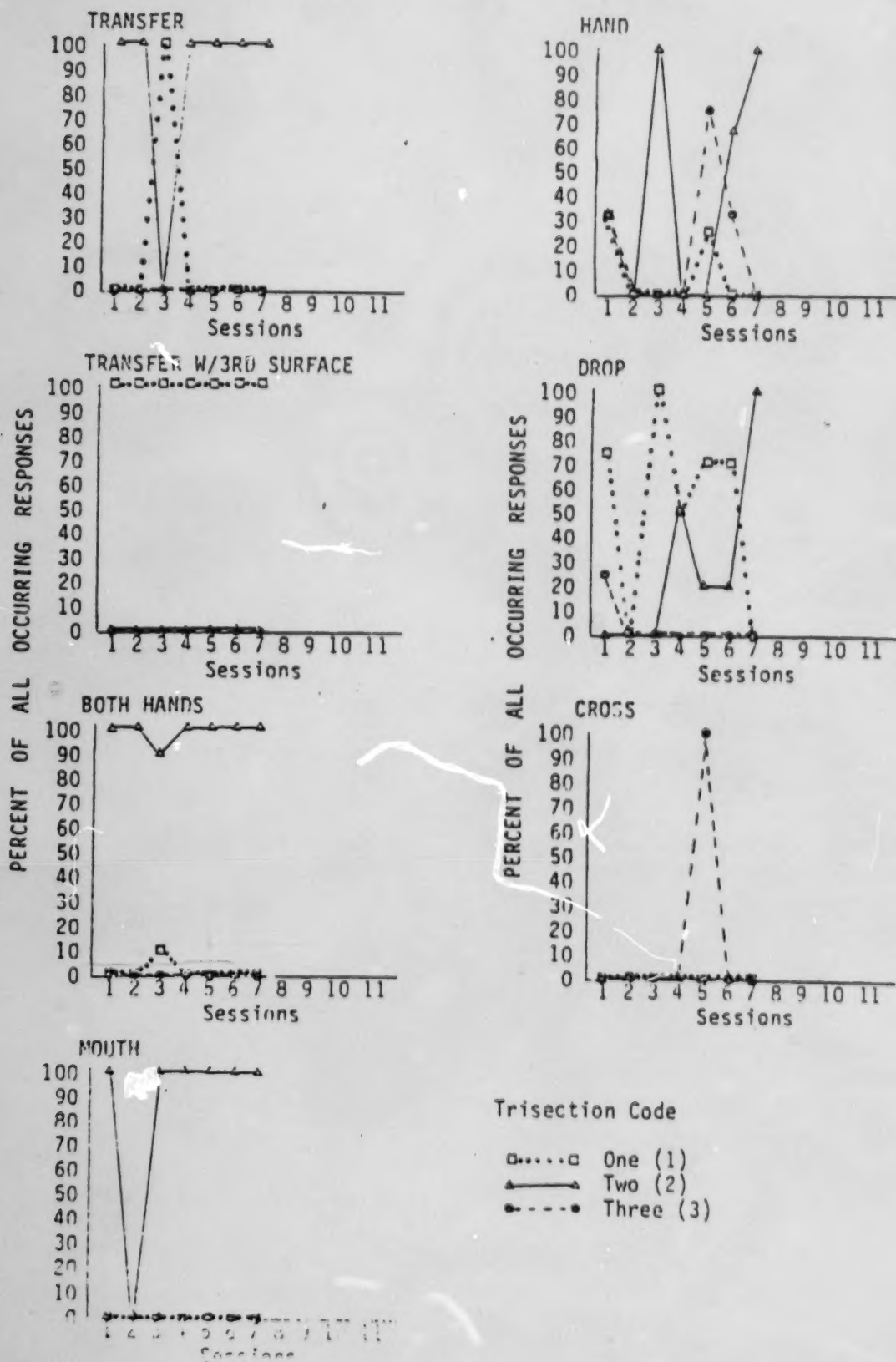


Figure 16. A comparison of responses made by Subject 4 in each trisection.

responses. Performance data for left and right presentation is represented in Figure 5. Greater fluctuation is noted in transfer response to left side presentation than right side presentation. This is an increasing trend in transfer with third surface responses when objects are presented to the right. Drop, cross, both hands and mouthing responses are fairly constant across sessions, but one hand responses fluctuate over time. Figure 9 presents the percent of each behavior response in each interval. The greatest number of both hand responses (transfer, transfer with third surface and drop) occur in the 5 to 10 second interval. This is true across sessions. There is one transfer response (Session 3) and one transfer with a third surface response (Session 9) occurring in the posttrial interval. Figure 13 represents the performance within each trisection. The majority of responses occur in trisection (2) with 100% of transfer, transfer with third surface, and both hand responses in this trisection. In four of the five sessions where cross responses occurred, 100% were in trisection (3), that is, the right hand moved to the left side of the body to grasp the object.

Subject 2 (Mike). Performance data are shown for 11 sessions. Data for large and small objects are represented in Figure 2. There is a slight increasing trend for transfer responses over time. Most transfer responses occur with both large and small objects and show an increase over time. There is a decreasing trend in both hands and across responses. Mouthing responses occur only on one day with large objects. Drop responses increase over time. Data for left and right presentations are shown in Figure 6. There is an increasing trend in transfer response with the right to left presentations. Transfer with third surface responses occur in both directions and remain consistent across time.

Both hands responses decrease toward the end of the sessions for both sides of presentation. Cross responses occurred more often with right side presentation. Figure 10 represents the percent of each response in each interval. The majority of both hands responses occurred in the pretrial interval and action responses (transfer, transfer with third surface and drop) occurred in the first 5-second interval. Figure 14 represents the performance within each trisection. The majority of responses occurred in trisection (2), but many also occurred in trisection (1). Very few responses occurred in trisection (3).

Subject 3 (David). Performance is shown for 6 sessions. Data for large and small objects is presented in Figure 3. There is a decreasing trend in overall transfer with third surface responses. Most of the activity occurred in both hand responses. Although responses fluctuate, they remain consistent over time for other responses. Data for left and right presentations is shown in Figure 7. Fairly equal numbers of responses occurred whether the object presented from the left or right side. Most of the activity occurred in both hands responses. Figure 11 represents the percent of each behavior response in each interval. Transfer and transfer with a third surface responses, when they occurred, were not in the pretrial interval. Both hands and drop responses occurred in all three intervals consistently across time. Mouthing which appeared to be increasing in the pretrial interval. Figure 15 represents the performance of each behavior within each trisection. Overall responses occurred in trisection (2), except drop responses which occurred in all trisections. There was an increasing trend in drop responses in trisection (1). Cross responses occurred in trisection (3) which reflects a right hand to left side movement.

Subject 4 (Greg). Performance data is shown for 7 sessions. Data for large and small objects is presented in Figure 4. There is a consistent level of transfer and transfer with third surface responses across time. There is a decreasing trend in both hand responses. There is an increasing trend in mouthing and drop responses. There is a consistent level of one hand responses overall, but fluctuation within sizes. Data for left and right presentations is shown in Figure 8. Greater numbers of transfer, transfer with third surface, and both hands responses occur when objects are presented to the left side. Greater numbers of mouthing and drop responses occur when objects are presented from the right side. Figure 12 represents the percent of each behavior response in each interval. The greatest number of transfer and transfer with third surface responses occur in the first 5-second interval. Transfer also occurred in the pretrial interval. The greatest number of both hands responses occurred in the pretrial interval. The highest number of drop responses occurred in the first 5-second interval. The other behavior responses occurred in all intervals. Figure 16 represents the performance within each trisection. The majority of transfer, both hands, and mouthing responses occurred in trisection (2). All transfer with third surface responses occurred in trisection (1). Drop responses occurred in all trisections, but most occurred in trisection (1). The cross response occurred in trisection (3). One hand responses occurred in all intervals.

Discussion

The procedures described by Mellard (Note 2) for measuring transfer skills were used with three handicapped preschoolers and one normally developing infant. The behavior and trisection descriptors were found

to reflect topography, but not qualitative differences in responses. Scoring behaviors which occurred at the end of the intervals resulted in omission of many behaviors. The major problems with this procedure were related to reliability measures. These included the amount of time and practice needed for an examiner to become reliable in scoring as well as continued reliability disagreements in coding behavior descriptors and time intervals.

Transfer responses were elicited using both of the techniques described in the methods section. It was found that all subjects tired of materials quickly and would continue to manipulate the original stimulus item if new objects were not presented frequently. A total of about thirty toys were used interchangeably among all subjects. Sometimes a subject would appear to develop a high preference during a session or across sessions. The subject might then persevere on mouthing or manipulating that specific item. The investigator needed to be alert to such developments. The higher preference item was presented as the cue for transfer rather than as the first item in the pretrial to avoid a continued mouthing for both hands response for the trial.

Several limitations were observed for behavior (refers to all transfer responses identified by Mellard) and trisection descriptors. Behavior descriptors used in this measurement tool presented topographies of responses. However, within each behavior descriptor qualitative differences were not apparent. For example, many types of one hand responses were observed. The normal subject (Subject 4) held the item in the original hand and banged the investigator's stimulus object repeatedly as if in a game. The score for this was (H). Subject 1 (handicapped) held the object in the original hand and waved it above

her head in front of crossed eyes. The score for this response was also (H). In addition, the behavior descriptors in this measurement procedure omit other object manipulations considered by some researchers to be at the same level as transfer (e.g., banging, visual and visual inspection) (Kopp, 1976; Ammon & Etzel, 1977).

Differences between transfer responses and transfer with a third surface responses were difficult to observe accurately. The primary difficulty seemed to be in determining exactly how close the object was to the subject's body. It was felt that a greater number of the disagreements in transfer response reliability were due to the scoring of a transfer with a third surface response.

Trisection descriptors appeared to reflect accurately the positions in which a behavior occurred. For example, in retrieving a toy to his right, Subject 2 turned slightly to the right and manipulated the object with both hands slightly off center. This was shown in the high number of trisection (3) responses scored with both hands responses.

It was felt that a variety of behaviors related to transfer were not being identified because of scoring at the end of the interval. Many styles of acceptance of objects were not scored. For example, the turning of a subject's trunk to grasp a toy while reaching with both hands was not reflected in the data. Other researchers consider the differences in hand functions within individuals as precursors to the development of manipulative skills and hand dominance (Bresson, et al., 1977).

Interobserver reliability for behavior and trisection descriptors across object size, side of presentation, and time interval ranged from 80-90%. Interobserver reliability for behavior descriptors and trisection

descriptors calculated individually for each descriptor ranged from 63-100%. Overall mean interobserver reliability for trisection (position) descriptors was higher at 93% than overall mean interobserver reliability for behavior descriptors at 74%. The grand mean interobserver reliability across all subjects was 88%. Types of reliability disagreements made were scoring in different intervals, confusing transfer responses with transfer with a third surface responses, and position discrepancies.

The first type of reliability disagreement was correct scoring of behavior response, but scoring in a different time interval. This may have been a result of the timing procedure used in the present study. A continuously running stopwatch was placed in view of the investigator and the reliability observer. Perhaps one looked at the watch just before the response occurred and the other looked at the watch immediately following the response. Each scored in a different interval. The timing procedure may have been the cause of another type of reliability disagreement. This would occur with subjects who moved rapidly from one response to another. Because the behavior response occurring at the end of the interval was scored, each observer might score a different response based on when the viewer glanced at the stopwatch.

Another type of reliability disagreement in behavior descriptors was a discrepancy between transfer responses and transfer with a third surface responses. This may have been due to the seating of the two observers in relation to the subject. Perhaps it was more difficult for a viewer to the side and behind the investigator to judge whether an object was touching or in front of a surface.

A third type of reliability disagreement involved trisection descriptors. In at least one session the investigator reversed the number codes for right and left resulting in 0% interobserver reliability on trisections for drop and cross responses.

In the present study the number of intervals observed per trial were expanded to include pretrial and posttrial. Sometimes a subject transferred independently before any cue. Because self-initiations are important training steps for multiply handicapped students, it was felt that self-initiated transfer should be scored separately from cued transfer. Then, because so many behaviors occurred between presentation of the first item and the cue to transfer, the behavior occurring immediately before the cue was recorded. It was felt that this might have a predictive value for response topographies, or that behaviors might occur sooner within trials over time. Several subjects did demonstrate transfer responses in the pretrial interval. In addition, it was felt that students should be given credit for transfers which began but were not concluded within the 5-10 second interval. For this reason the posttrial interval was created. It was felt that some multi-handicapped children might need more time to perform the skill due to motor involvement.

This measurement procedure was not reliable until the investigator practiced for about five sessions using an adult to simulate the subject while organizing the processes, i.e., materials presentation, stopwatch starting, and data recording. There was at least one unreliable session at the beginning of data collection for each subject, including the final subject whose sessions were initiated until two months into the procedure with the other subjects. In addition, session 4 for Subject 2

was unreliable. This was the only incident of mid-study session reliability.

Performance of transfer and transfer with third surface responses remained the same for the normally developing Subject 4 but other responses varied over time. This may have been due to the fact that all seven sessions were observed within four weeks and that four weeks is not long enough to observe change. It may also reflect the fact that transfer skills once emerged, do not change in frequency over time.

Several recommendations for further research can be made. A larger number of subjects including those with visual and hearing impairments should be assessed, as well as a larger group of normal subjects. Longitudinal research should be conducted in order to verify the developmental sequence of the skills and to demonstrate performance growth of subjects. This research could also contribute toward determining the effectiveness of this assessment for monitoring small changes in transfer skills in order to modify the intervention procedures.

Reference Notes

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A REPLICATION STUDY:
Quantitative Measurement of Head Erect
in the Prone and Supported Sitting
Position in Nonhandicapped Infants¹

by
Jane Purcell Rues

¹The procedures and data reported in this study were taken from a Doctoral dissertation by Jane Purcell Rues that was submitted to the Department of Special Education, University of Kansas, in 1981.

Overview of Measurement Procedures

Volume I, Assessment Procedures for Selected Developmental Milestones pages HE19-HE42, described procedures used by Foshage (1978) in the original head erect study. The procedures in the original study measured head erect in prone, pull to sit and recline, and supported sitting. Volume II, pages HE1-HE18 present the performance and reliability results from the original study.

Measurement Procedure Revisions

Head erect behaviors in two positions, prone and supported sitting, were selected for revision and longitudinal replication. The original procedures for measuring head erect in the prone position included two observation schedules: Schedule A which was primarily a frequency measure, and Schedule B which was a duration measure. Schedule A required a 3 minute observation session: the responses (i.e., head bobs emitted by the child) constituted the number of trials during the 3 minute timing. The duration of head lifts and arm positions were recorded if the head was raised longer than 5 seconds. Schedule B included a series of discreet trials (minimum of 5 and maximum of 10) in which duration of the head lift and the position(s) of the arms were recorded.

The transition between these two system (i.e., from 3 minute observation periods to 5 to 10 trials) was made when the child maintained a head erect position for 60 seconds during a 3 minute period. Only durations of head erect greater than 5 seconds were added together to get this number.

The revised measurement procedure combined components of Observation Schedule A and Observation Schedule B. The 3 minute observation session was maintained and the code was adapted to allow for simultaneous recordings

of the following behaviors: frequency of head turns and lifts, duration of longest head lift, cumulative duration of head erect, and frequency of arm positions. The descriptor, head turns, represented an addition to the code. When the cumulative duration of head erect behavior equalled 160 seconds on 2 out of 3 sessions, the duration measure was then applied to the descriptor, extended arm props. The focus in the 3 minute observation session was then directed at measures of frequency of extended arm props, cumulative duration of extended arm props and frequency of arm positions.

The data sheet was changed to accommodate the above revisions and can be used to measure the behaviors (i.e., head erect and extended arm props) sequentially, simultaneously, or independently. The imposed ceiling of 3 minutes on cumulative duration of head erect and extended arm props far exceeds the duration measures specified in the standardized and nonstandardized assessments previously reviewed.

The original procedure for measuring head erect in support sitting involved two measures (frequency or duration). A specified criterion determined when the observer changed from a frequency measure to a duration measure. The revised procedure combined both measures allowing for simultaneous recordings of frequency of head erect in a 3 minute observation session. This revision was made in an effort to systematically collect data on emergence and acquisition in a nonhandicapped population. Additions to the data sheet were also necessary in the provision of external support to the infant in the supported sitting position. A sequence of support positions from cephalo to caudal (shoulder to pelvis) was defined and included in an effort to quantify the emergence and acquisition of this skill in the nonhandicapped sub-

jects. The initial criterion for change in the provision of external support to the subject (i.e., maintenance of the vertical position for 30 seconds) resulted in a too abrupt decrease in support for nonhandicapped subjects.

Subjects

Six nonhandicapped infants were selected for this study because of their predictable development of head erect behavior and to allow for the application of the procedures throughout the entire sequence of development. Further documentation of the sensitivity of the procedure to subtle changes in head erect behavior was accomplished by the inclusion of two sets of identical twins in addition to two single infants. Selection criteria included: (a) a normal prenatal and post-partum history, (b) birth weight of more than 5 pounds 8 ounces, and (c) an Apgar score of 7 to 10 at 5 minutes.

Subject 1

Robin was the first born by cesarean section of identical female twins. Robin's birth weight was 5 pounds 9½ ounces; the Apgar score at 5 minutes was 9. A right congenital hip dislocation was diagnosed at 1 day of age. Intervention for the hip dislocation required that the infant wear a harness to maintain the lower extremities in abduction and external rotation. With treatment the hip dislocation resolved and the harness was removed when the subject was 4 months of age.

The mental and motor scales of the Bayley Scales of Infant Development were administered when Robin was 1 month of age. Robin obtained a raw score of 17 on the mental scale and a raw score of 9 on the motor scale. Developmental Indexes are not computed for this age group but both scores indicate a functional development well within the norm.

Subject 2

Debra was the second born by cesarean section of identical female twins. Debra's birth weight was 6 pounds 8 ounces; the Apgar score at 5 minutes was 8.

The mental and motor scales of the Bayley Scales of Infant Development were administered when Debra was 1 month of age. Debra obtained a raw score of 14 on the mental scale and a raw score of 9 on the motor scale, a functional development well within the norm.

Subject 3

Helen was the first born of identical female twins. Helen's birth weight was 6 pounds 15 ounces; the Apgar score at 5 minutes was 9.

The mental and motor scales of the Bayley Scales of Infant Development were administered when Helen was 5 weeks of age. Helen obtained a raw score of 16 on the mental scale and a raw score of 13 on the motor scale, a functional development well within the norm.

Subject 4

Julie was the second born of identical female twins. Julie's birth weight was 5 pounds 10 ounces; the Apgar score at 5 minutes was 8.

The mental and motor scales of the Bayley Scales of Infant Development were administered when Julie was 5 weeks of age. Julie obtained a raw score of 13 on the mental scale and a raw score of 12 on the motor scale, a functional development well within the norm.

Subject 5

Gary was a single infant delivered by cesarean section to a woman whose previous delivery had been by cesarean section. Gary weighed 7 pounds 13 ounces at birth; the Apgar score at 5 minutes was 8.

At approximately 9 weeks of age a suspected visual problem, congenital nystagmus was confirmed by a pediatric ophthalmologist. Congenital nystagmus is a hereditary disorder transmitted as a sex-linked autosomal dominant. Results of the brainstem evoked visual response test suggested that light perception was present. A complete neurological examination by the pediatrician indicated that neuro-motor development was well within normal limits. Based on the results of the above assessments, this subject was continued in the study.

Subject 6

Carrie was a single infant. Carrie's birth weight was 7 pounds 3 ounces; the Apgar score at 5 minutes was 9.

Procedures for Obtaining Measures of Reliability

Measures of Reliability for Head Erect in Prone

Reliability measures were taken from direct observation of the infant. Reliability for head turns and head lifts was computed by using the following formula:

$$\frac{\# \text{ of agreements}}{\# \text{ of agreements} + \text{disagreements}} \times 100.$$

The reliability figures for each session were added together and divided by the number of sessions to obtain the average reliability figure for these descriptors.

The above formula was employed for computing reliability for arm position. Although there were 7 possible descriptors for arm position, only occurrence data were computed in determining the reliability for each session. The reliability figures for each session were added together and divided by the number of sessions to obtain the average reliability for arm position(s).

Reliability for duration of longest head lift and cumulative duration of head erect behavior was computed separately by using the following formula:

$$\frac{\text{smaller duration}}{\text{larger duration}} \times 100.$$

Percentage of agreement on duration was computed as follows: the smaller duration number was divided by the larger duration number and multiplied by 100 to obtain a percentage for each session. The scores from each session were added together and divided by the number of sessions to obtain the average reliability score for each descriptor (i.e., duration of longest head lift and cumulative duration of head erect behavior).

When the cumulative duration of head erect equalled 160 seconds on 2 out of 3 sessions, the focus in the 3 minute observation session was directed towards arm position and the cumulative duration for extended arm props.

Reliability for extended arm props was computed by using the following formula:

$$\frac{\# \text{ of agreements}}{\# \text{ of agreements} + \text{disagreements}} \times 100.$$

The reliability figures for each session were added together and divided by the number of sessions to obtain the average reliability figures for this descriptor.

The above formula was also employed for computing reliability for arm position(s). Only occurrence data were computed in determining the reliability for each session. The reliability figures for each session were added together and divided by the number of sessions to obtain the average reliability for arm position(s).

Reliability for cumulative duration of extended arm props was computed by using the following formula:

$$\frac{\text{small duration}}{\text{larger duration}} \times 100.$$

The scores from each session were added together and divided by the number of sessions to obtain the average reliability score for the descriptor.

Measures of Reliability for Head Erect in Supported Sitting

Reliability for frequency of head erect was computed by using the following formula:

$$\frac{\# \text{ of agreements}}{\# \text{ of agreements} + \text{disagreements}} \times 100.$$

The reliability figures for each session were added together and divided by the number of sessions to obtain the average reliability figure for this descriptor.

Reliability for cumulative duration of head erect was computed by using the following formula:

$$\frac{\text{smaller duration}}{\text{larger duration}} \times 100.$$

The scores for each session were added together and divided by the number of sessions to obtain the average reliability score for this descriptor.

Persons participating in the reliability measurements on the nonhandicapped infants included the investigator, a secretary, a physical therapist and an occupational therapist. The physical and occupational therapists were the mothers of the two single infants in this study.

Results

Measures of Interobserver Reliability

Tables 1-3 present interobserver reliability data for the behavior descriptors for head erect in the prone position, upper extremity weight bearing in the prone position and head erect in the supported sitting position for individual subjects and across subjects. Tables 4-19 present interobserver reliability data for head erect in the prone position, upper extremity weight bearing in the prone position and head erect in the supported sitting position calculated individually across sessions.

Subject 1 (Robin). Interobserver reliability for head erect in the prone position across all behavior descriptors ranged from 92% - 99% with a mean of 96% (see Table 1); for upper extremity weight bearing in the prone position ranged from 84% - 98% with a mean of 93% (see Table 2); and in the supported sitting position ranged from 92% - 97% with a mean of 94% (see Table 3).

Interobserver reliability data for head erect across sessions are presented in Tables 4-6. For head erect in the prone position (see Table 4), interobserver reliability ranged from 75% - 100%. Row mean reliability ranged from 93% - 100%, and the grand mean reliability was 96%. For upper extremity weight bearing in the prone position (see Table 5), interobserver reliability ranged from 63% - 100%. Row mean reliability ranged from 87% - 99% and the grand mean reliability was 93%. For head erect in the supported sitting position (see Table 6), interobserver reliability ranged from 80% - 100%. Row mean reliability ranged from 88% - 100% and the grand mean reliability was 94%.

Table 1
Interobserver Reliability Across Behavior Descriptors for Head Erect
in the Prone Position for Individual Subjects and Across Subjects

Behavior Descriptors	Reliability for all sessions per subject						Row Mean Reliability
	1	2	3	4	5	6	
Head turns	-	-	-	-	100	93	96
Head lifts	96	89	93	92	97	88	92
Duration longest head lift	99	99	97	99	98	92	97
Cumulative duration	99	98	96	96	95	94	96
Arm position	92	93	84	88	90	84	88
Column mean reliability	96	94	92	93	96	90	Grand mean reliability 93

Table 2

Interobserver Reliability Across Behavior Descriptors for Upper Extremity
Weight Bearing in the Prone Position for Individual Subjects and Across Subjects

Behavior Descriptors	Reliability for all sessions per subject						Row Mean Reliability
	1	2	3	4	5	6	
Extended arms	98	97	89	95	96	96	95
Cumulative duration	97	93	96	97	94	97	95
Arm position	84	89	85	87	88	85	86
Column mean reliability	93	93	90	93	92	92	Grand mean reliability 92

Table 3

Interobserver Reliability Across Behavior Descriptors for Head Erect
in the Supported Sitting Position for Individual Subjects and Across Subjects

Behavior Descriptors	Reliability for all sessions per subject				Row Mean Reliability
	1	2	3	4	
Head erect	92	93	91	91	91
Cumulative duration	97	97	97	95	96
Column mean reliability	94	94	94	93	Grand mean reliability 93

Table 4

Reliability Scores for Head Erect in the Prone Position for Robin

Session Number	Reliability per session				Row Mean Reliability
	Head lifts	Duration longest lift	Cumulative duration	Arm position	
3	80	-	98	100	93
4	100	-	97	100	99
6	90	95	94	100	95
7	100	100	100	100	100
11	100	100	100	-	100
12	100	100	100	75	94
13	100	100	100	75	94
Column mean reliability	96	99	99	92	Grand mean reliability 96

Table 5
Reliability Scores for Upper Extremity Weight Bearing
in the Prone Position for Robin

Session Number	Reliability per session			Row Mean Reliability
	Extended arms	Cumulative duration	Arm position	
14	100	100	71	90
15	100	97	63	87
16	100	99	94	98
17	100	100	83	94
18	100	97	100	99
19	88	91	84	88
20	100	99	100	99
21	100	98	83	93
Column mean reliability	96	97	84	Grand mean reliability 93

Table 6

Reliability Scores for Head Erect in the Supported Sitting Position for Robin

Session Number	Reliability per session		Row Mean Reliability
	Head erect	Cumulative duration	
2	100	93	96
3	80	96	88
4	100	100	100
6	100	100	100
7	83	99	91
10	100	100	100
13	90	98	94
15	80	98	89
18	93	95	94
19	100	100	100
Column mean reliability	92	97	Grand mean reliability 94

Subject 2 (Debra). Interobserver reliability for head erect in the prone position across all behavior descriptors ranged from 89% - 99% with a mean of 94% (see Table 1); for upper extremity weight bearing in the prone position ranged from 89% - 97% with a mean of 93% (see Table 2); and for head erect in the supported sitting position ranged from 93% - 97% with a mean of 94% (see Table 3).

Interobserver reliability data for head erect across sessions are presented in Tables 7-9. For head erect in the prone position (see Table 7), interobserver reliability ranged from 67% - 100%. Row mean reliability ranged from 89% - 99%, and the grand mean reliability was 94%. For upper extremity weight bearing in the prone position (see Table 8), interobserver reliability ranged from 74% - 100%. Row mean reliability ranged from 87% - 99%, and the grand mean reliability was 93%. For head erect in the supported sitting position (see Table 9), interobserver reliability ranged from 83% - 100%. Row mean reliability ranged from 83% - 100% and the grand mean reliability was 94%.

Subject 3 (Helen). Interobserver reliability for head erect in the prone position across all behavior descriptors ranged from 84% - 97% with a mean of 92% (see Table 1); for upper extremity weight bearing in the prone position ranged from 85% - 96% with a mean of 90% (see Table 2); and for head erect in the supported sitting position ranged from 91% - 97% with a mean of 94% (see Table 3).

Interobserver reliability data for head erect across sessions are presented in Tables 10-12. For head erect in the prone position (see Table 10), interobserver reliability ranged from 33% - 100%. Row mean reliability ranged from 83% - 100% and the grand mean reliability was 92%. For upper extremity weight bearing in the prone position (see

Table 7

Reliability Scores for Head Erect in the Prone Position for Debra

Session Number	Reliability per session				Row Mean Reliability
	Head lifts	Cumulative duration	Duration longest bob	Arm position	
2	90	98	-	100	96
4	100	99	100	100	99
6	75	98	95	100	92
8	83	96	99	-	93
9	100	98	98	100	99
11	67	99	100	-	89
12	100	100	100	71	93
13	100	100	100	89	97
Column mean reliability	89	98	99	93	Grand mean reliability 94

Table 8
Reliability Scores for Upper Extremity Weight Bearing
in the Prone Position for Debra

Session Number	Reliability per session			Row Mean Reliability
	Extended arms	Cumulative duration	Arm position	
14	100	100	93	98
15	100	80	81	87
16	93	90	91	91
17	100	96	100	99
18	100	95	100	98
19	82	97	88	89
20	100	98	83	94
21	100	90	74	88
Column mean reliability	97	93	89	Grand mean reliability 93

Table 9

Reliability Scores for Head Erect in the Supported Sitting Position for Debra

Session Number	Reliability per session		Row Mean Reliability
	Head erect	Cumulative duration	
2	85	-	85
3	100	97	98
4	100	97	98
6	100	100	100
7	83	99	91
10	100	98	99
13	87	97	92
15	100	97	98
18	93	95	94
19	84	100	92
Column mean reliability	93	97	Grand mean reliability 94

Table 10

Reliability Scores for Head Erect in the Prone Position for Helen

Session Number	Reliability per session				Row Mean Reliability
	Head lifts	Cumulative duration	Duration longest bob	Arm position	
2	90	-	-	100	95
5	100	100	100	100	100
6	85	85	92	100	91
7	87	91	89	100	91
8	75	98	100	100	93
9	100	100	100	50	87
10	100	99	99	100	99
11	100	100	100	75	93
12	100	100	100	33	83
Column mean reliability	93	96	97	84	Grand mean reliability 92

Table 11
Reliability Scores for Upper Extremity Weight Bearing
in the Prone Position for Helen

Session Number	Reliability per session			Row Mean Reliability
	Extended arms	Cumulative duration	Arm position	
13	100	100	88	96
14	100	100	87	96
15	100	87	93	93
16	100	91	88	93
18	71	98	81	83
19	85	97	66	83
20	80	96	87	88
21	66	96	80	81
22	100	99	100	99
Column mean reliability	89	96	85	Grand mean reliability 90

Table 12

Reliability Scores for Head Erect in the Supported Sitting Position for Helen

Session Number	Reliability per session		Row Mean Reliability
	Head erect	Cumulative duration	
4	100	97	98
7	100	98	99
10	100	100	100
13	75	94	84
15	90	98	94
19	83	96	89
Column mean reliability	91	97	Grand mean reliability 94

Table 11), interobserver reliability ranged from 66% - 100%. Row mean reliability ranged from 81% - 99% and the grand mean reliability was 90%. For head erect in the supported sitting position (see Table 12) interobserver reliability ranged from 75% - 100%. Row mean reliability ranged from 84% - 100% and the grand mean reliability was 94%.

Subject 4 (Julie). Interobserver reliability for head erect in the prone position across all behavior descriptors ranged from 88% - 99% with a mean of 93% (see Table 1); for upper extremity weight bearing in the prone position ranged from 87% - 97% with a mean of 93% (see Table 2); and for head erect in the supported sitting position ranged from 91% - 95% with a mean of 93% (see Table 3).

Interobserver reliability data for head erect across sessions are presented in Tables 13-15. For head erect in the prone position (see Table 13), interobserver reliability ranged from 60% - 100%. Row mean reliability ranged from 80% - 99% and the grand mean reliability was 93%. For upper extremity weight bearing in the prone position (see Table 14), interobserver reliability ranged from 73% - 100%. Row mean reliability ranged from 85% - 100% and the grand mean reliability was 93%. For head erect in the supported sitting position (see Table 15), interobserver reliability ranged from 85% - 100%. Row mean reliability ranged from 90% - 98% and the grand mean reliability was 93%.

Subject 5 (Gary). Interobserver reliability for head erect in the prone position across all behavior descriptors ranged from 88% - 100% with a mean of 95% (see Table 1); and for upper extremity weight bearing in the prone position ranged from 88% - 96% with a mean of 92% (see Table 2).

Table 13

Reliability Scores for Head Erect in the Prone Position for Julie

Session Number	Reliability per session				Row Mean Reliability
	Head lifts	Cumulative duration	Duration longest bob	Arm position	
3	90	90	-	100	93
5	100	93	100	100	93
6	87	96	100	100	95
7	92	93	100	100	96
8	83	97	98	100	94
9	100	100	100	60	90
10	100	98	99	100	99
11	75	99	-	66	80
12	100	100	100	70	92
Column mean reliability	92	96	99	88	Grand mean reliability 93

Table 14
Reliability Scores for Upper Extremity Weight Bearing
in the Prone Position for Julie

Session Number	Reliability per session			Row Mean Reliability
	Extended arms	Cumulative duration	Arm position	
13	100	90	83	91
14	81	94	79	85
15	85	100	86	90
16	100	98	73	90
18	100	98	85	94
19	100	100	100	100
20	100	99	100	99
Column mean reliability	95	97	87	Grand mean reliability 93

Table 15

Reliability Scores for Head Erect in the Supported Sitting Position for Julie

Session Number	Reliability per session		Row Mean Reliability
	Head erect	Cumulative duration	
4	88	94	91
7	87	97	92
10	100	97	98
13	100	97	98
15	90	94	93
19	85	96	90
Column mean reliability	91	95	Grand mean reliability 93

Interobserver reliability data for head erect across sessions are presented in Tables 16 and 17. For head erect in the prone position (see Table 16), interobserver reliability ranged from 72% - 100%. Row mean reliability ranged from 89% - 100% and the grand mean reliability was 94%. For upper extremity weight bearing in the prone position (see Table 17), interobserver reliability ranged from 75% - 100%. Row mean reliability ranged from 86% - 97% and the grand mean reliability was 92%.

Subject 6 (Carrie). Interobserver reliability for head erect in the prone position across all behavior descriptors ranged from 84% - 94% with a mean of 90% (see Table 1), and for upper extremity weight bearing in the prone position ranged from 85% - 97% with a mean of 92% (see Table 2).

Interobserver reliability data for head erect across sessions are presented in Tables 18 and 19. For head erect in the prone position (see Table 18), interobserver reliability ranged from 50% - 100%. Row mean reliability ranged from 79% - 100% and the grand mean reliability was 89%. For upper extremity weight bearing in the prone position (see Table 19), interobserver reliability ranged from 50% - 100%. Row mean reliability ranged from 70% - 100% and the grand mean reliability was 92%.

Overall interobserver reliability. Interobserver reliability for head erect in the prone position across all behavior descriptors and all subjects ranged from 84% - 100%. Row mean reliability ranged from 88% - 96%, and the grand mean reliability was 93% (see Table 1). Interobserver reliability for upper extremity weight bearing in the prone position across all behavior descriptors and all subjects ranged from 84% - 98%.

Table 16

Reliability Scores for Head Erect in the Prone Position for Gary

Session Number	Reliability per session				Arm position	Row Mean Reliability
	Head turns	Head lifts	Duration longest lift	Cumulative duration		
2	100	90	-	78	100	92
3	-	93	97	98	100	97
5	-	100	98	97	100	98
6	-	100	99	98	72	92
8	-	100	98	97	75	92
9	-	100	99	98	83	95
11	-	100	100	100	100	100
Column mean reliability	100	97	98	95	90	Grand mean reliability 95

Table 17
Reliability Scores for Upper Extremity Weight Bearing
in the Prone Position for Gary

Session Number	Reliability per session			Row Mean Reliability
	Extended arms	Cumulative duration	Arm position	
12	100	85	75	86
13	100	91	100	97
15	100	99	95	98
17	100	98	83	93
19	80	99	87	88
Column mean reliability	96	94	88	Grand mean reliability 92

Table 18

Reliability Scores for Head Erect in the Prone Position for Carrie

Session Number	Reliability per session					Row Mean Reliability
	Head turns	Head lifts	Cumulative duration	Duration longest bob	Arm position	
1	100	100	90	-	100	96
2	-	100	100	100	100	100
3	100	50	100	66	100	79
4	100	80	80	88	100	87
5	100	83	90	85	100	89
6	66	100	94	97	75	91
7	-	83	97	100	50	82
8	-	100	100	100	55	88
9	-	100	100	100	84	96
Column mean reliability	93	88	94	92	84	Grand mean reliability 89

Table 19
Reliability Scores for Upper Extremity Weight Bearing
in the Prone Position for Carrie

Session Number	Reliability per session				Row Mean Reliability
	Extended arms	Cumulative duration	Arm position		
10	100	100	88		96
11	100	100	81		93
12	100	100	100		100
13	100	100	92		97
14	100	100	91		97
17	100	100	85		95
18	100	100	83		94
19	100	100	75		91
20	100	100	84		94
21	100	75	88		87
22	50	100	62		70
23	100	100	77		92
24	100	100	100		100
25	100	85	84		89
Column mean reliability	96	97	85		Grand mean reliability 92

Row mean reliability ranged from 86% - 95%, and the grand mean reliability was 92% (see Table 2). Interobserver reliability for head erect in the supported sitting position across all behavior descriptors and all subjects ranged from 91% - 97%. Row mean reliability ranged from 91% - 96%, and the grand mean reliability was 93% (see Table 3).

Comparison of reliability scores for arm positions. Interobserver reliability was recomputed to determine the agreement of the observers across all arm positions (i.e., agreement of frequency) emitted by the subject per session. The same formula was used for computing reliability on the agreement of the observers across all arm positions. The reliability figures for each session were added together and divided by the number of sessions to obtain the average reliability score for agreement across all arm positions. Table 20 presents a comparison of overall interobserver reliability scores for arm positions for individual subjects and across subjects. Interobserver reliability for agreement on individual arm movements across all subjects ranged from 84% - 90% with a mean reliability of 86%. Interobserver reliability for agreement across all arm positions across all subjects ranged from 88% - 94% with a mean reliability of 91%.

Performance Measures

The subjects are grouped in sets of two for presentation of the performance data in the graphs in Figures 1-17. The data on each set of identical female twins are presented and the two single infants comprise the third set of subjects.

Set 1 (Robin and Debra). Figure 1 presents performance data on the frequency of head lifts and the cumulative duration of head erect for each subject. The data on head lifts indicated that an initial sharp

Table 20
Comparison of Interobserver Reliability Scores for Arm Position
for Individual Subjects and Across All Subjects

	<u>Reliability for all sessions per subject</u>						Row Mean Reliability
	1	2	3	4	5	6	
Agreement on individual arm positions	87	90	84	87	89	84	86
Agreement across all arm positions	93	93	88	94	92	90	91

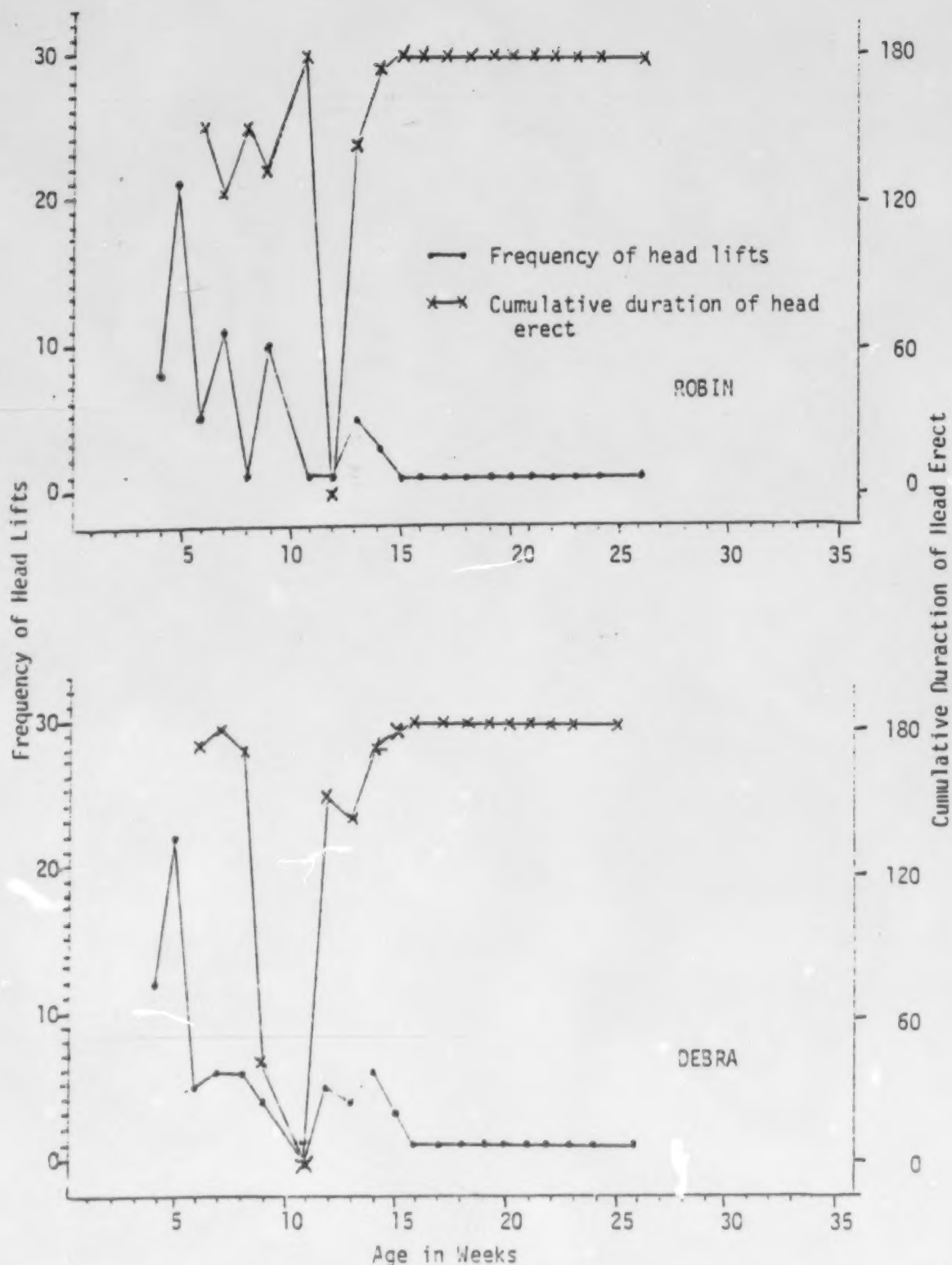


Figure 1. Frequency of head lifts and cumulative duration of head erect in a 3 minute session for Set 1 in the prone position. Data for both subjects, Robin (upper graph) and Debra (lower graph) presented by chronological age in weeks.

increase in frequency between 4 weeks and 5 weeks of age was followed by a decreasing trend in occurrence for both subjects. This decrease in head lifts was accompanied by an increasing trend in cumulative duration of head erect for Robin (from 150 seconds to 180 seconds) but followed by a sharp decrease in duration at week 12, and was associated with an initial high stable level of cumulative duration between weeks 6-8 but was followed by a sharp decrease in duration between weeks 9-11 for Debra. Head lifts decreased to one per session at week 16 for Robin and at week 17 for Debra with a corresponding cumulative duration of 180 seconds.

Figure 2 presents performance data on the total number of arm positions and the frequency of extended arm props. The emergence of weight bearing in the upper extremities (week 12 for Debra; week 13 for Robin) was followed by an increasing trend in the number of arm positions emitted by the subjects' per session. Following week 20 a decreasing trend was demonstrated, although marked fluctuations were noted between the subsequent weekly sessions. The final data point preceded the emergence of creeping.

Figure 3 presents performance data on the cumulative duration of head erect and extended arm props and the duration of the longest head lift. Performance data on cumulative duration of head erect and the duration of the longest head lift indicated increasing trends between 6 weeks and 11 weeks for Robin but were followed by sharp decreases in duration at week 12. Between weeks 13-15, both cumulative duration of head erect and duration of longest head lift demonstrated a parallel reacquisition slope. Performance data on cumulative duration of head erect for Debra indicated an initial high stable level of response

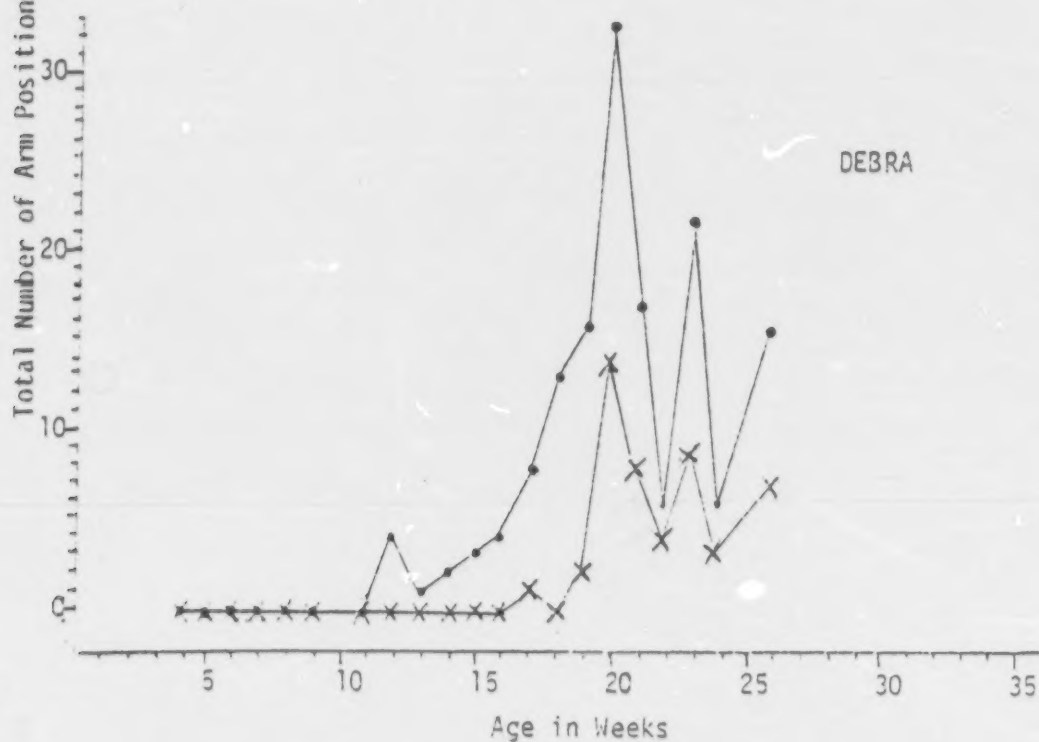
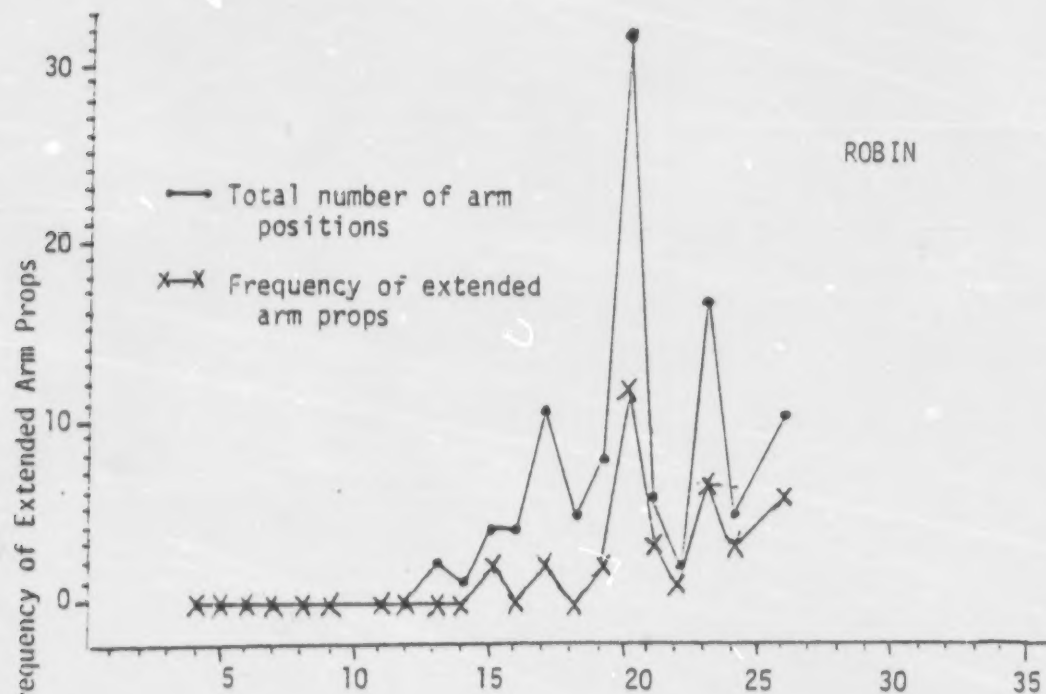


Figure 2. Total number of arm positions and frequency of extended arm props in a 2 minute session for Set 1 in the prone position. Data for both subjects, Robin (upper graph) and Debra (lower graph) presented by chronological age in weeks.

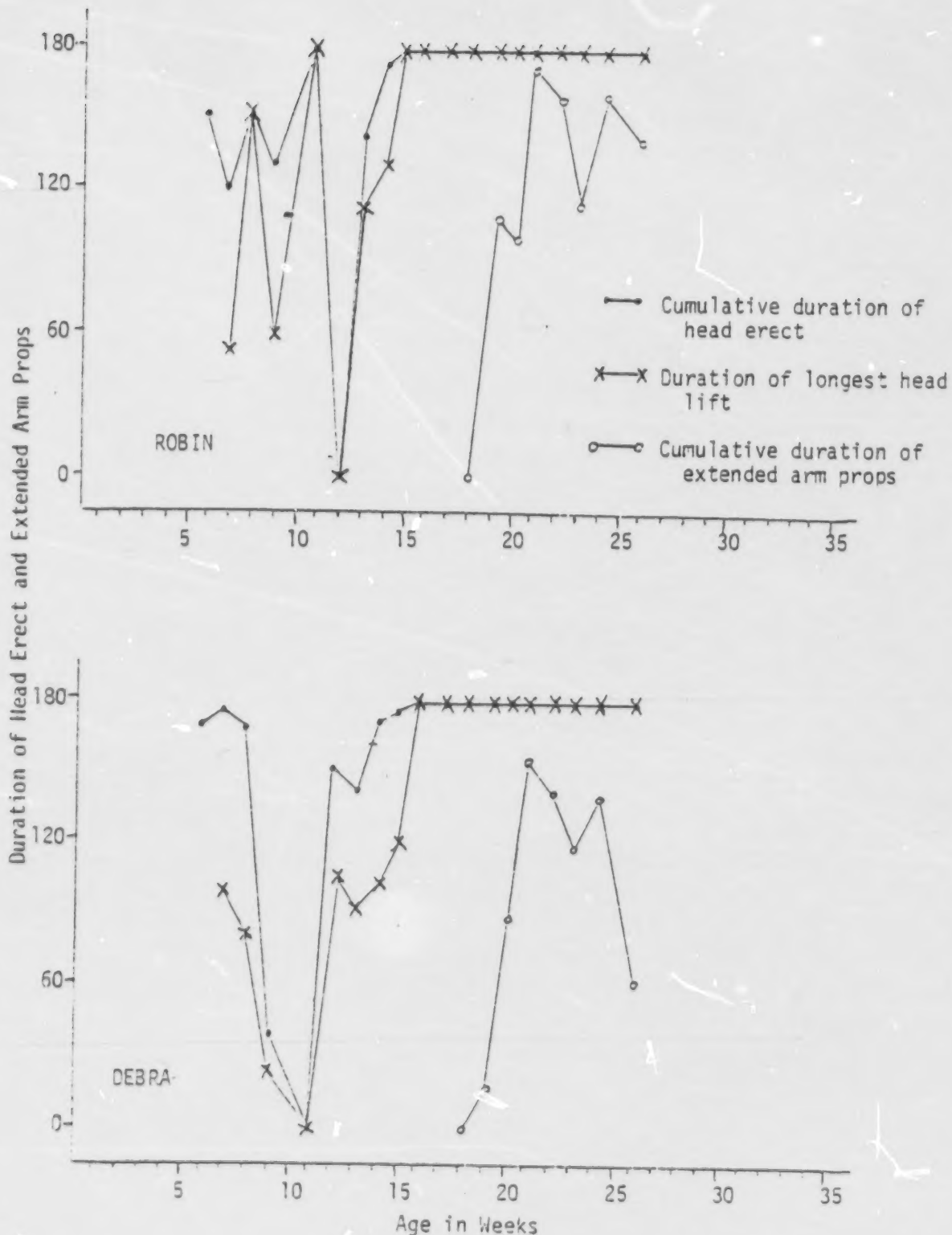


Figure 3. Cumulative duration of head erect, duration of longest head lift and cumulative duration of extended arm props in a 3 minute session for Set 1 in the prone position. Data for both subjects, Robin (upper graph) and Debra (lower graph) presented by chronological age in weeks.

between weeks 6-8. This was followed by a decrease in duration between 9 weeks and 11 weeks. Duration of longest head lift demonstrated a decreasing trend between weeks 7-11. Between 12 weeks and 15 weeks, data on both cumulative duration and duration of longest head lift indicated an increasing trend. Performance data on cumulative duration of extended arm props indicated a sharp increase between weeks 18 and 21 for both subjects followed by a decreasing trend between weeks 22 and 26.

Performance data on the frequency of extended arm props and cumulative duration of extended arm props (Figure 4) indicated an initial parallel acquisition (i.e., duration increased as frequency increased) between weeks 18 and 20.

Figure 5 presents performance data on movement in the position (i.e., head lifts and arm positions). Three phases are illustrated in the graph. In the initial phase (weeks 4-11 for Debra; weeks 4-12 for Robin), a sharp increase in head lifts was followed by a decreasing trend in the occurrence of the behavior. The second phase (weeks 12-16 for Debra; weeks 13-15 for Robin) demonstrated a transition between decreasing head lifts and the emergence of upper extremity weight bearing. In the third phase (weeks 17-26 for Debra; weeks 16-26 for Robin) the frequency of head lifts decreased to one per session accompanied by an increasing trend in the number of arm positions. Following week 20 a decreasing trend was demonstrated; although marked fluctuations were noted between subsequent weekly sessions.

Figure 6 presents performance data on the frequency and cumulative duration of head erect in the supported sitting position for each subject.

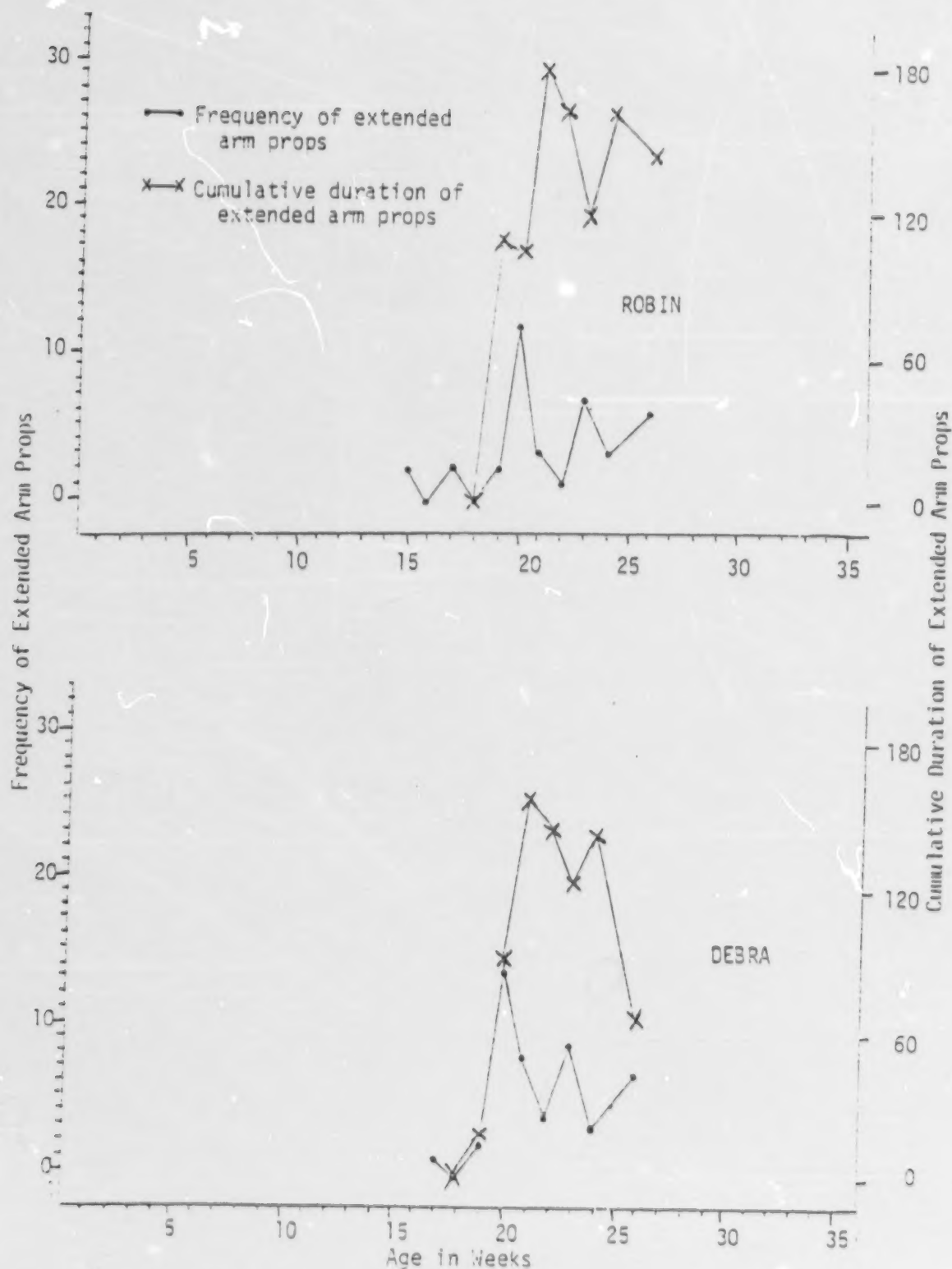


Figure 4. Frequency and cumulative duration of extended arm props in a 3 minute session for Set 1 in the prone position. Data for both subjects, Robin (upper graph) and Debra (lower graph) presented by chronological age in weeks.

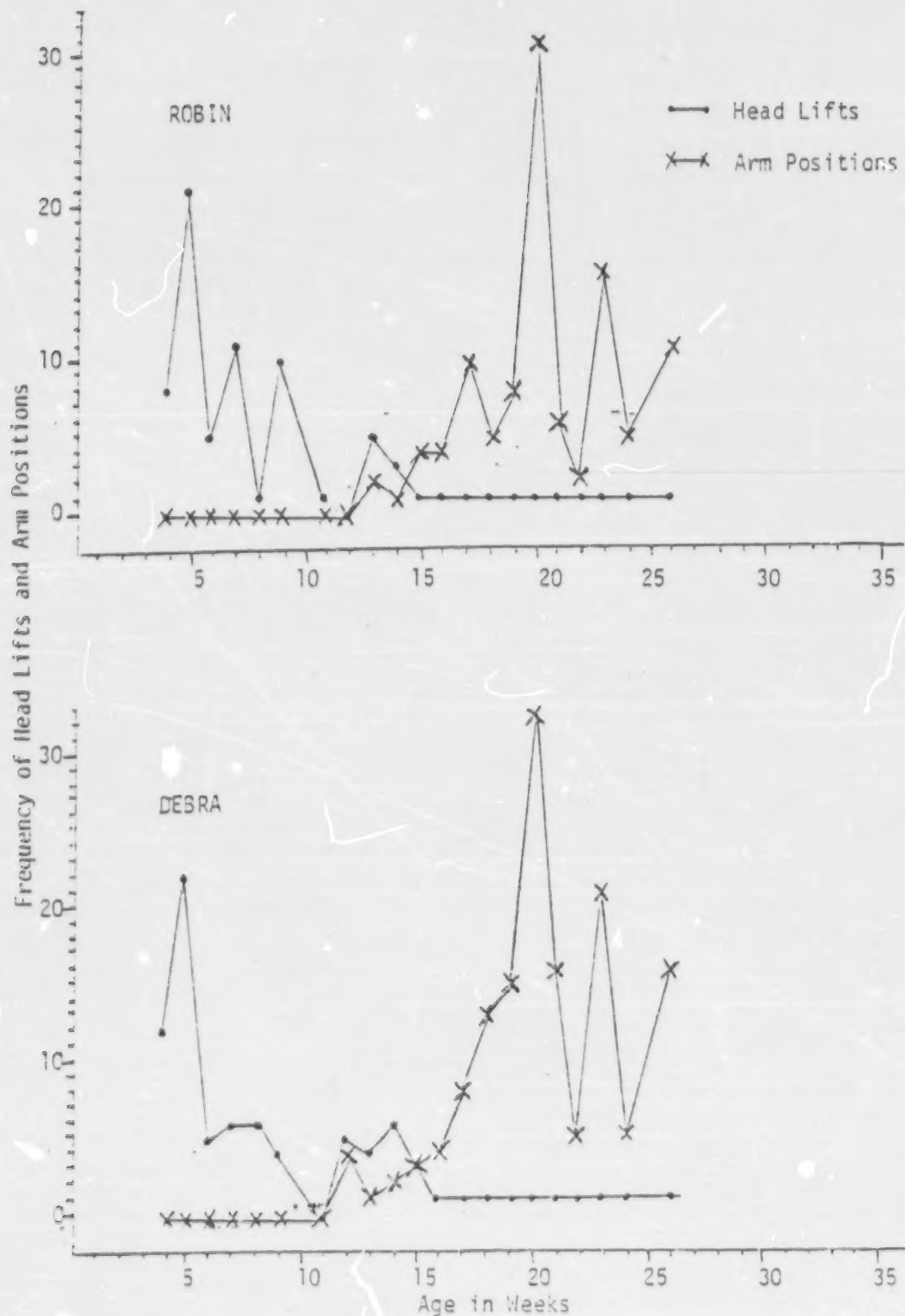


Figure 5. Frequency of head lifts and arm positions in a 3 minute session for Set 1 in the prone position. Data for both subjects, Robin (upper graph) and Debra (lower graph) presented by chronological age in weeks.

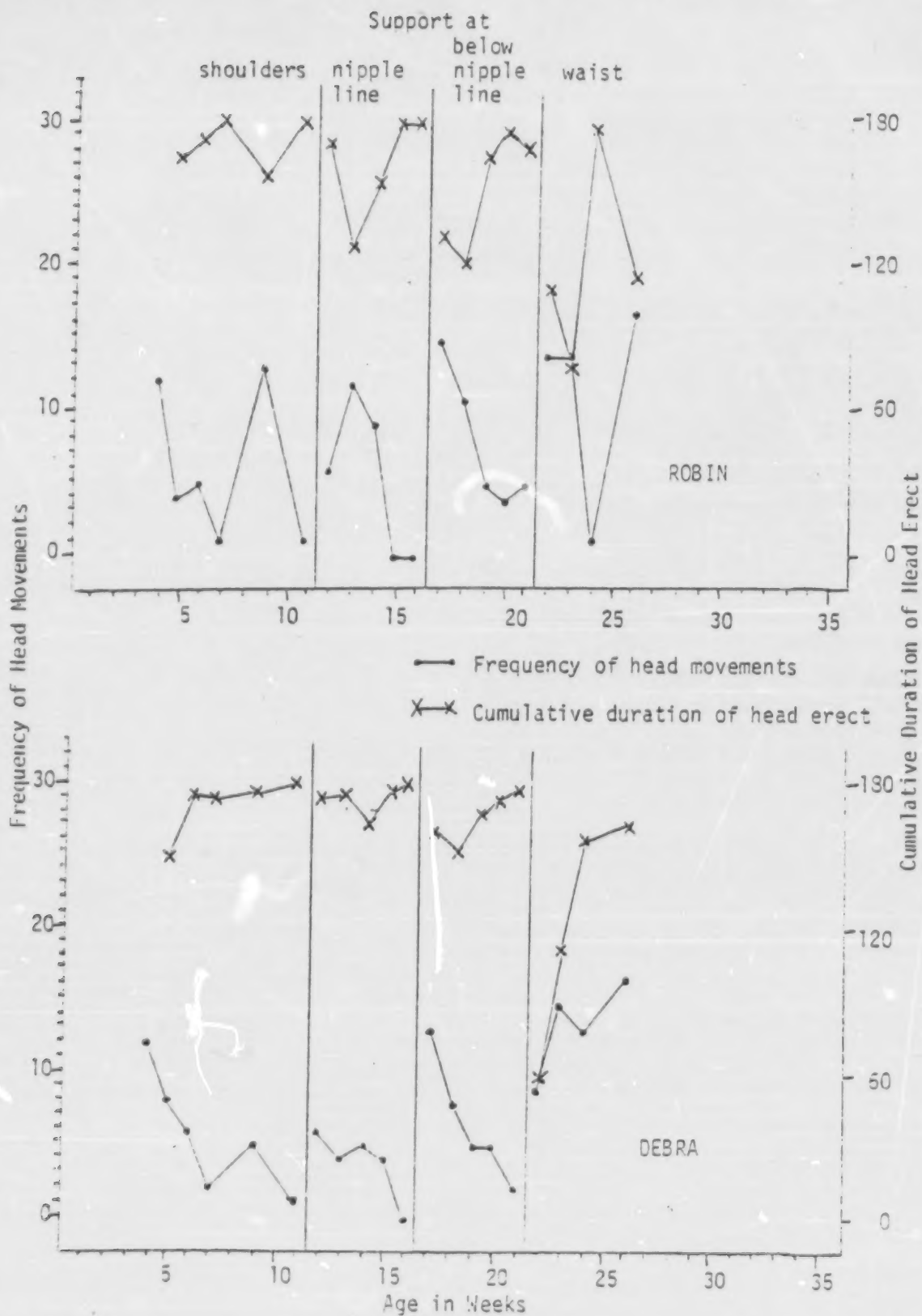


Figure 6. Frequency of head movements and cumulative duration of head erect in a 3 minute session for Set 1 in the supported sitting position. Data for both subjects, Robin (upper graph) and Debra (lower graph) presented by chronological age in weeks.

In the first three conditions (shoulder support, support at the nipple line, and support below the nipple line), the data indicated an inverse relationship between frequency of head movements and cumulative duration of head erect for both Robin and Debra. An initial increase in head movements followed each change of condition for Robin and Debra.

Performance data on the fourth condition for Robin demonstrated that the decrease in support was accompanied by an increase in head movement in and out of the third trisection and a decrease in cumulative duration of head erect. This trend was reversed at week 24 as frequency of head movements decreased and cumulative duration increased. The final data point for Robin, depicting another reversal between frequency and cumulative duration, was the result of self-initiated rocking by the subject. The performance data for Debra in this condition indicated that an initial increase in the frequency of head movements was accompanied by a decrease in cumulative duration of head erect. Subsequent data on cumulative duration of head erect indicated an increasing trend between weeks 24-26, accompanied by fluctuations in the frequency of head movements.

Set 2 (Helen and Julie). Figure 7 presents performance data on the frequency of head lifts and the cumulative duration of head erect for each subject. The data on head lifts indicated that an initial sharp increase in frequency (between week 3 and week 5 for Helen; between week 3 and week 6 for Julie) was followed by a decreasing trend in occurrence for both subjects. This decrease of head lifts was accompanied by a slight increasing trend in cumulative duration of head erect with a sharp increase in cumulative duration occurring at week 12 for both subjects.

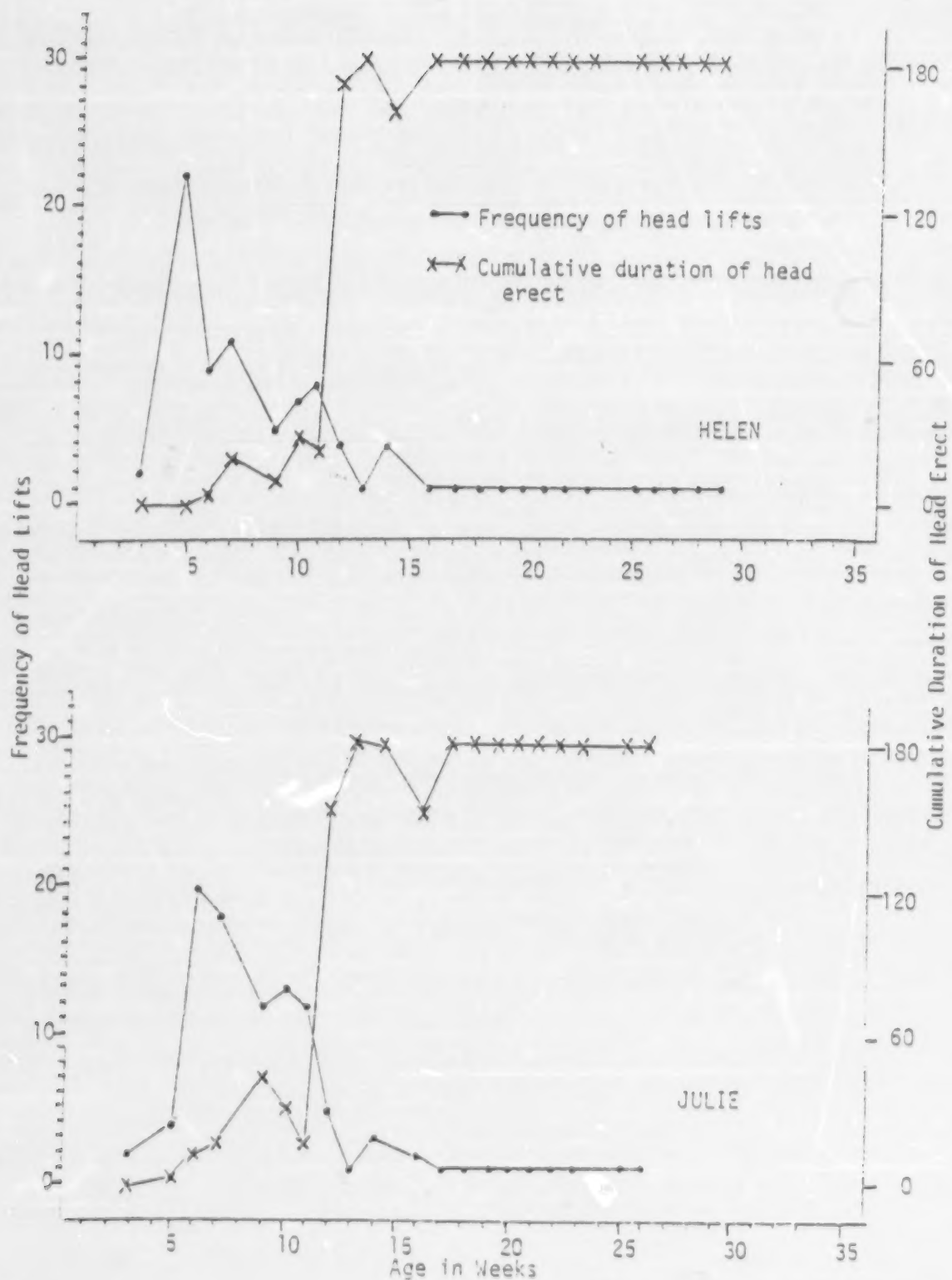


Figure 7. Frequency of head lifts and cumulative duration of head erect in a 3 minute session for Set 2 in the prone position. Data for both subjects, Helen (upper graph) and Julie (lower graph) presented by chronological age in weeks.

Figure 8 presents performance data on the total number of arm positions and the frequency of extended arm props for both subjects. The emergence of weight bearing in the upper extremities at week 11 for both subjects was followed by an increasing trend in the number of arm positions emitted by the subjects' per session. This trend was followed by a decreasing trend for both subjects in the number of arm positions per session. The final data point preceded the emergence of creeping for Julie and Helen. The emergence of extended arm props was recorded at week 18 for both subjects.

Figure 9 presents performance data on the cumulative duration of head erect and extended arm props and the duration of the longest head lift for each subject. Performance data on cumulative duration of head erect indicated a slight increasing trend with a sharp increase in cumulative duration at week 12 for both subjects. Cumulative duration of head erect remained uniformly high for the remainder of the study. The performance data on the duration of the longest head lift paralleled the acquisition slope of the data on cumulative duration of head erect. Performance data on the cumulative duration of extended arm props indicated a sharp increasing trend followed by maintenance of the response at relatively high levels.

Figure 10 presents performance data on the frequency of extended arm props and the cumulative duration of extended arm props. Performance data for Helen demonstrated an initial parallel acquisition between weeks 20 and 22 followed by a decreasing trend in frequency of extended arm props. Performance data for Julie demonstrated an initial parallel acquisition between weeks 18 and 19 and an inverse relationship on subsequent weeks.

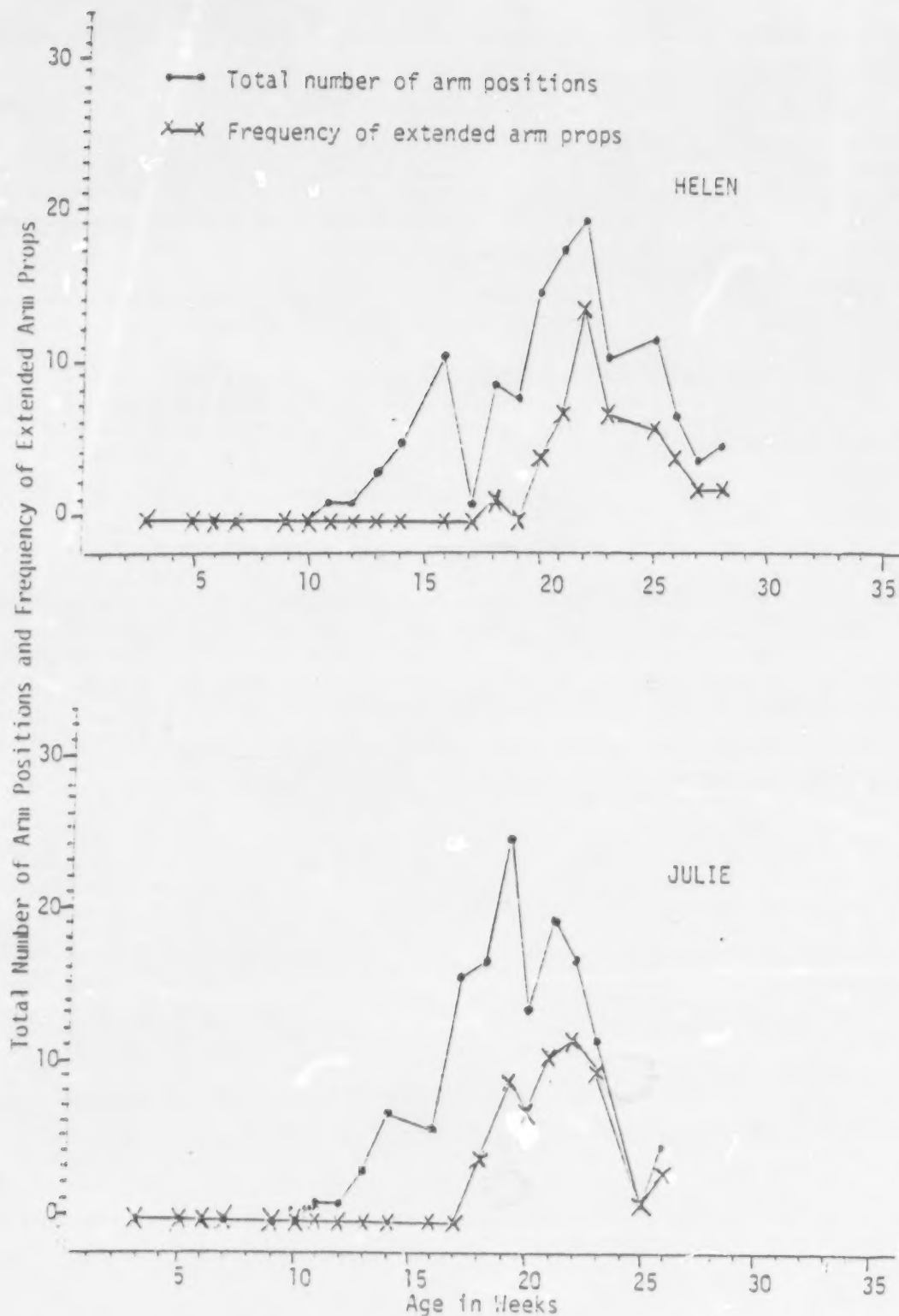


Figure 8 . Total number of arm positions and frequency of extended arm props in a 3 minute session for Set 2 in the prone position. Data for both subjects, Helen (upper graph) and Julie (lower graph) presented by chronological age in weeks.

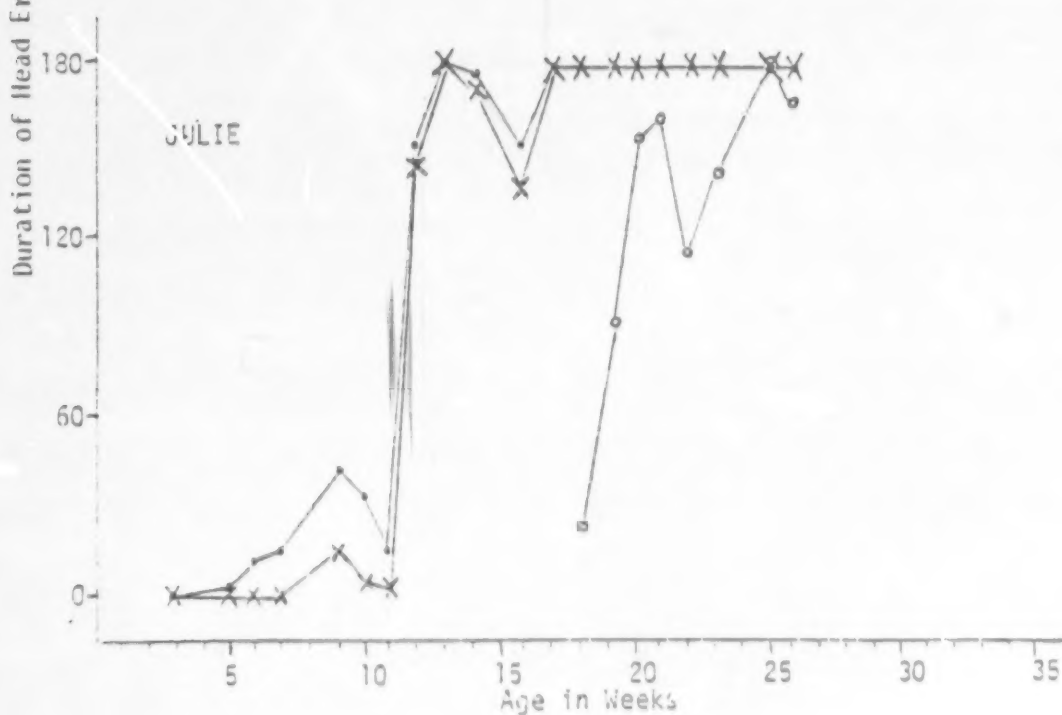
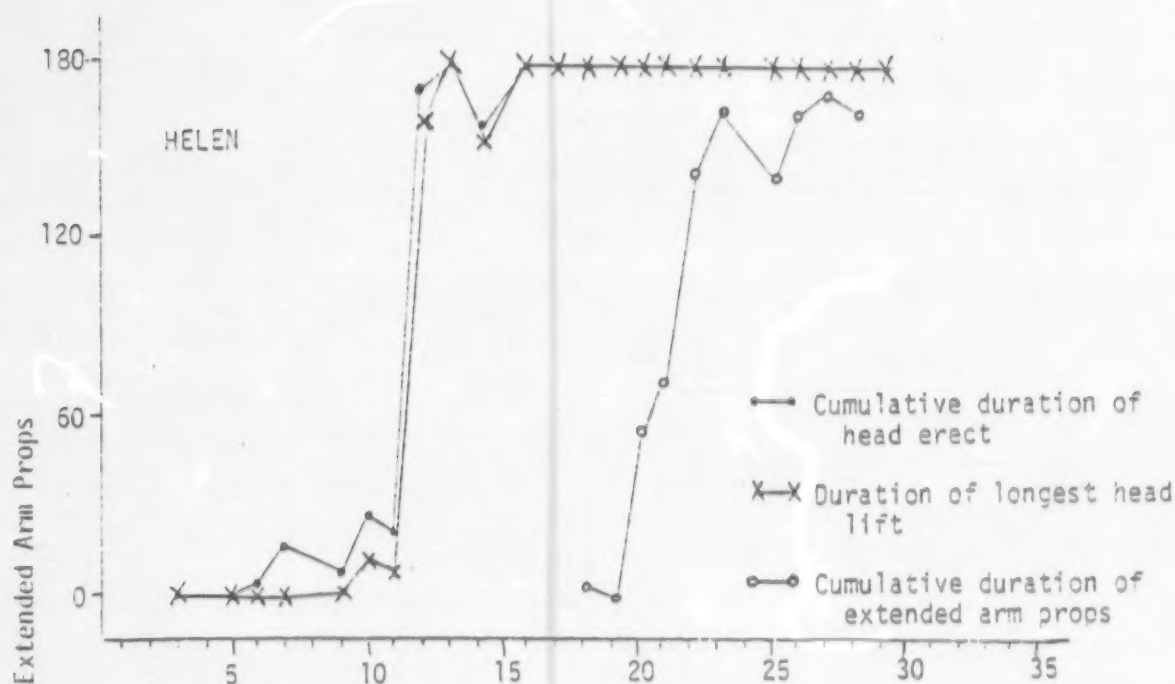


Figure 9. Cumulative duration of head erect, duration of longest head lift and cumulative duration of extended arm props in a 3 minute session for Set 2 in the prone position. Data for both subjects, Helen (upper graph) and Julie (lower graph) presented by chronological age in weeks.

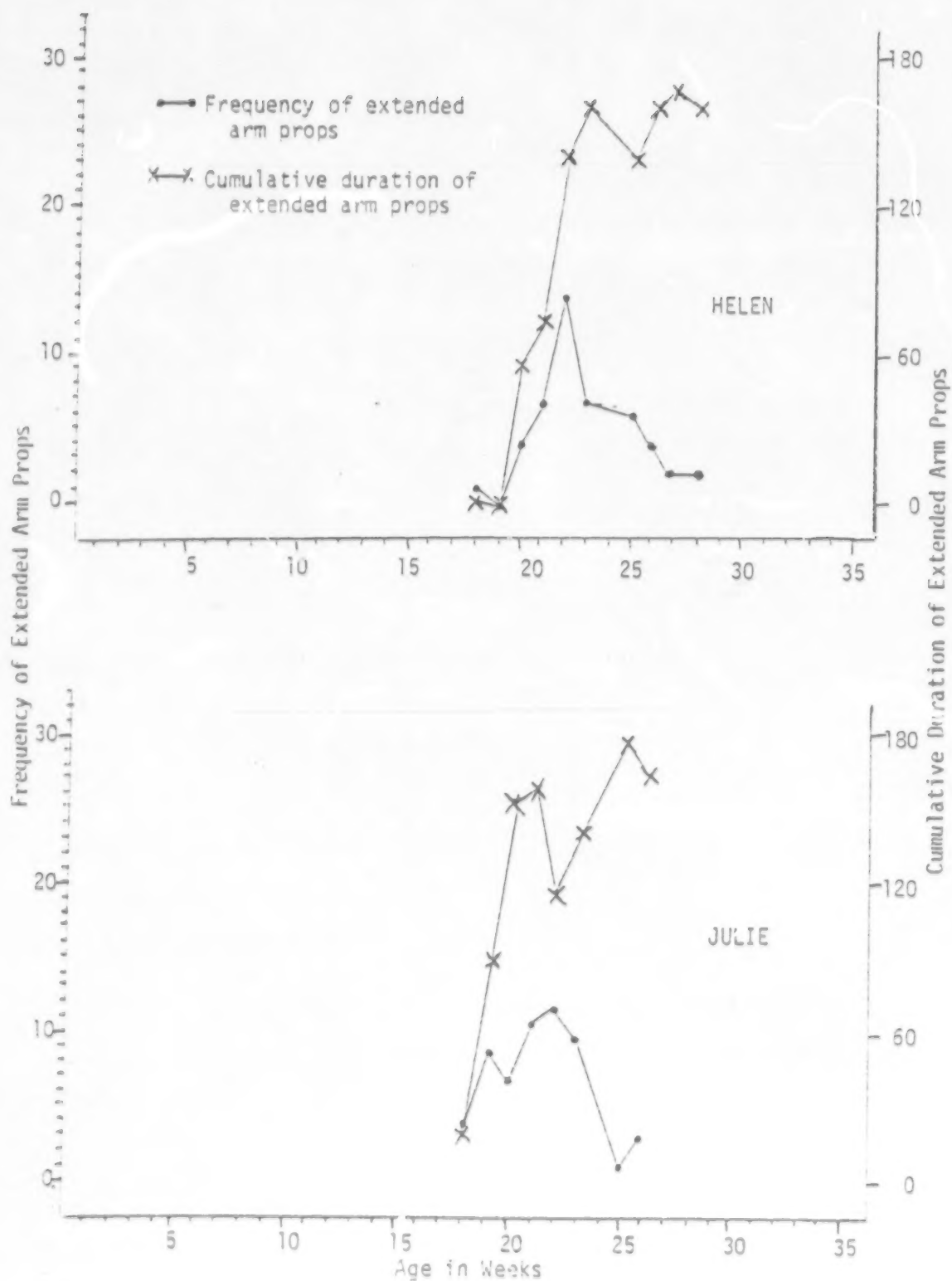


Figure 10. Frequency and cumulative duration of extended arm props in a 3 minute session for Set 2 in the prone position. Data for both subjects, Helen (upper graph) and Julie (lower graph) presented by chronological age in weeks.

Figure 11 presents performance data on movement in the position (i.e., head lifts and arm positions). Three phases are illustrated in the graphs. In the initial phase a sharp increase in head lifts was followed by a decreasing trend in the occurrence of the behavior. The second phase (weeks 14-15 for Helen; weeks 14-16 for Julie) demonstrated a transition between decreasing head lifts and the emergence of upper extremity weight bearing. In the third phase the frequency of head lifts decreased to one per session accompanied by an increasing trend in the number of arm positions that subsequently decreased.

Figure 12 presents performance data on the frequency and cumulative duration of head erect in the supported sitting position. The solid vertical lines in the graphs represented a condition change in the provision of external support to the infant.

The performance data for Helen in the first condition (i.e., shoulder support) indicated a decreasing trend in the frequency of head movements in and out of the third trisection accompanied by an increasing trend in cumulative duration of head erect. The performance data for Julie in this condition demonstrated a relatively stable level of head movements in and out of the third trisection accompanied by an increasing trend in cumulative duration.

The performance data for Helen in the second condition demonstrated an increase in frequency of head movements in and out of the third trisection accompanied by an initial decrease in cumulative duration of head erect. Subsequent data on cumulative duration of head erect indicated an increasing trend with a decrease in frequency of head movements on the final data point of this condition. The performance data for Julie in this condition demonstrated a decreasing trend in frequency of

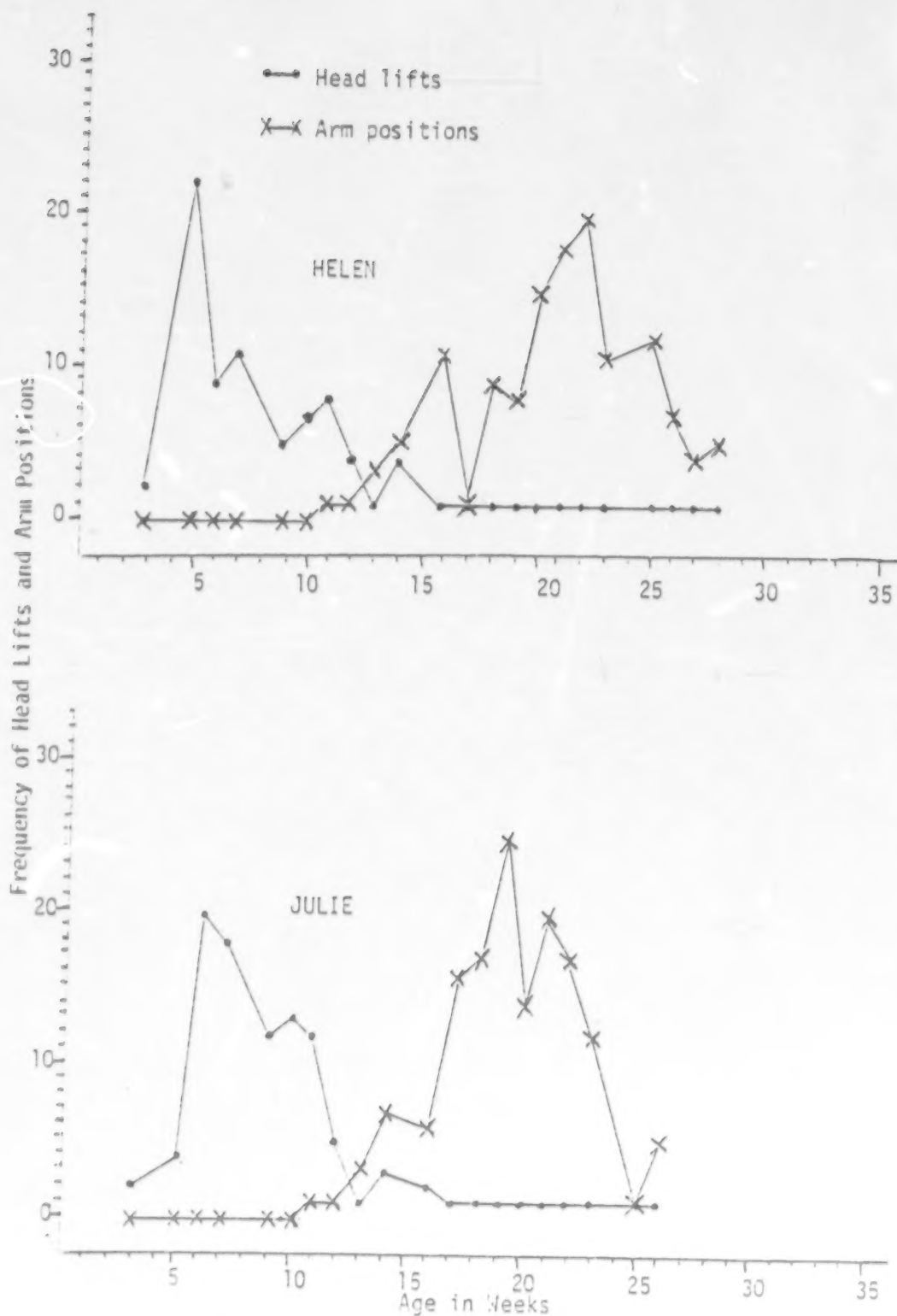


Figure 11. Frequency of head lifts and arm positions in a 3 minute session for Set 2 in the prone position. Data for both subjects, Helen (upper graph) and Julie (lower graph) presented by chronological age in weeks.

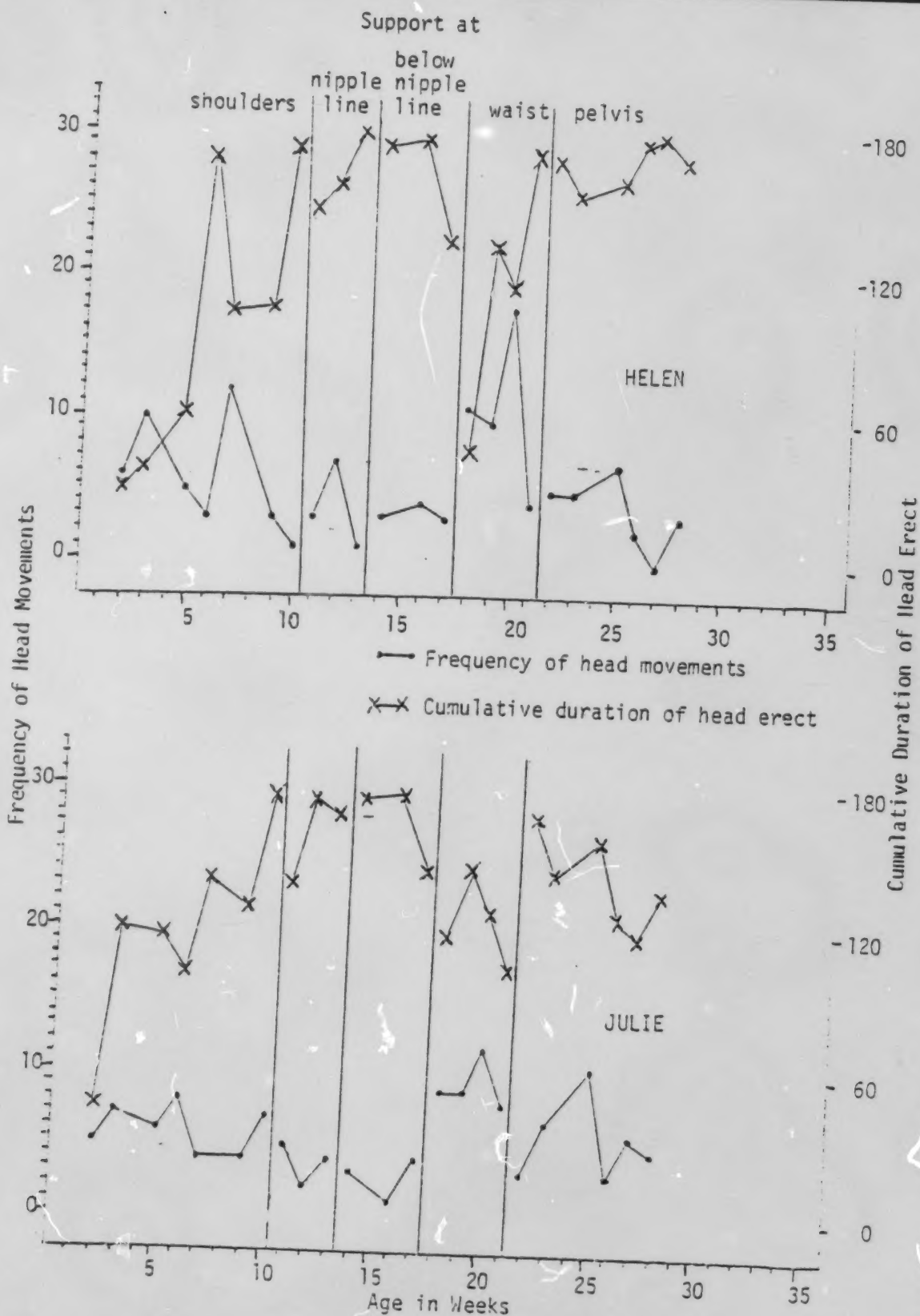


Figure 12. Frequency of head movements and cumulative duration of head erect in a 3 minute session for Set 2 in the supported sitting position. Data for both subjects, Helen (upper graph) and Julie (lower graph) presented by chronological age in weeks.

head movements accompanied by an initial decrease followed by an increase in cumulative duration of head erect.

The performance data for Helen in the third condition indicated a slight increase in frequency of head movements followed by a low stable level. Data on cumulative duration demonstrated a high stable level of occurrence followed by a decrease on the final data point of this condition. The performance data for Julie demonstrated a decrease in frequency of head movements accompanied by a high stable level of cumulative duration of head erect.

The performance data for Helen in the fourth condition indicated an increasing trend in the frequency of head movements accompanied by an initial sharp decrease in cumulative duration. Subsequent data on cumulative duration demonstrated an increasing trend with a decrease in frequency of head movement on the last data point of this condition. Performance data for Julie in this condition indicated an increasing trend in frequency of head movements accompanied by a decreasing trend in cumulative duration. This trend subsequently reversed.

The performance data for Helen in the fifth condition indicated a slight increase in frequency of head movements accompanied by an initial decrease in cumulative duration of head erect. Subsequent data on cumulative duration indicated an increasing trend accompanied by a decreasing trend in frequency of head movement. The performance data for Julie indicated an increase in frequency of head movements followed by a decrease. Data on cumulative duration indicated a decreasing trend.

Set 3 (Gary and Carrie). Figure 13 presents performance data on the frequency of head lifts and the cumulative duration of head erect

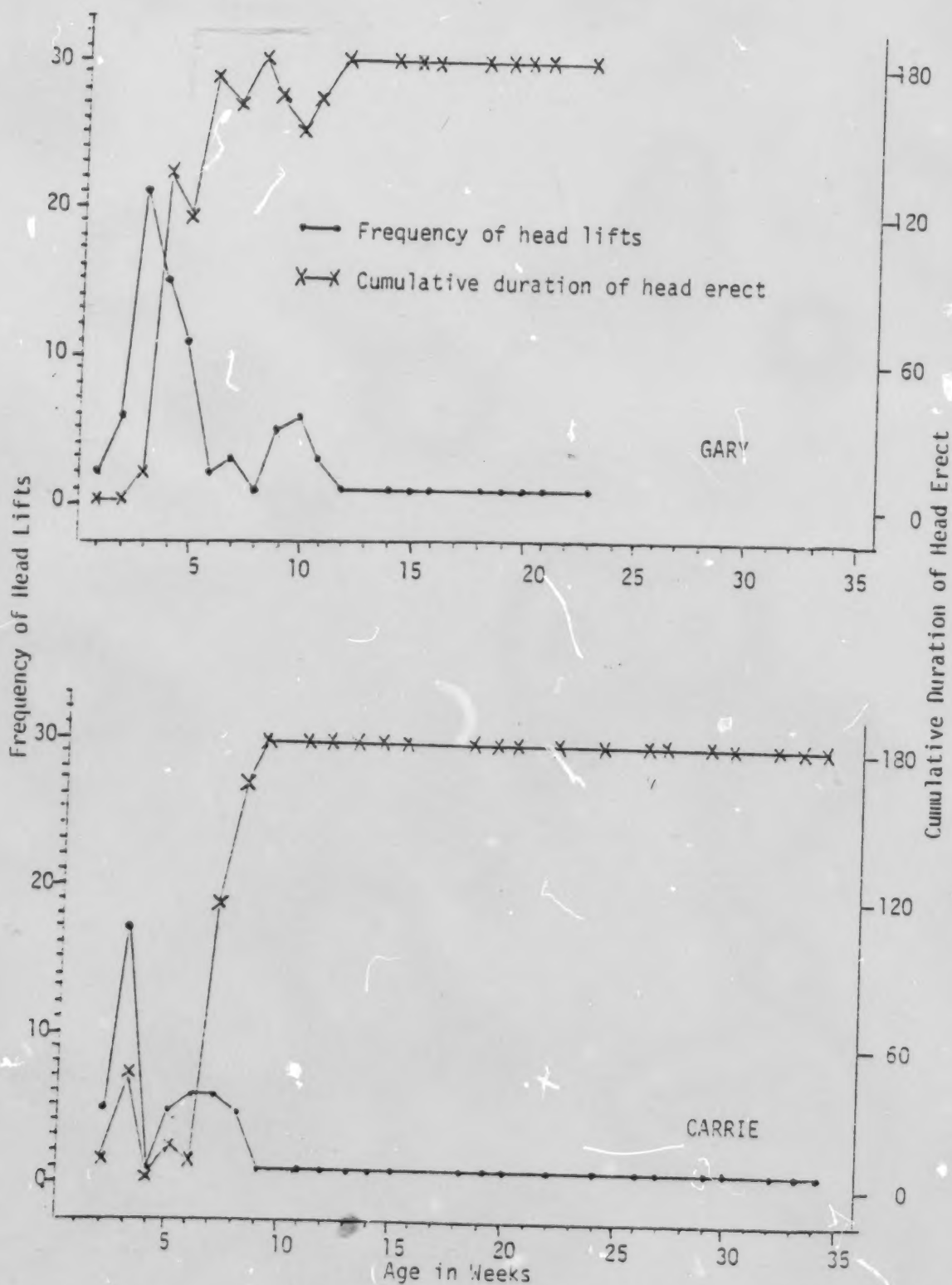


Figure 13. Frequency of head lifts and cumulative duration of head erect in a 3 minute session for Set 3 in the prone position. Data for both subjects, Gary (upper graph) and Carrie (lower graph) presented by chronological age in weeks.

for the two single infants. The data on head lifts for Gary indicated that an initial sharp increase in frequency between 1 week and 3 weeks of age was followed by a decreasing trend in occurrence. This decrease in head lifts between 4 weeks and 8 weeks was accompanied by an increasing trend in cumulative duration.

The data on head lifts for Carrie indicated an initial sharp increase in frequency between 2 weeks and 3 weeks of age followed by an abrupt decrease at week 4. Data on cumulative duration of head erect demonstrated a corresponding low level increase between weeks 2-3 with a decrease at week 4 and a sharp increase at week 7. The cumulative duration of 180 seconds at week 9 was maintained for the remaining weeks of the study.

Figure 14 presents the performance data on the total number of arm positions and the frequency of extended arm props for each subject. The emergence of weight bearing in the upper extremities at week 4 for Gary was followed by an increasing trend in the number of arm positions and was followed by a decreasing trend. The final data point preceded the emergence of creeping. Extended arm props were first observed at week 14 for Gary and paralleled the data on total number of arm positions but at a lower frequency.

The emergence of weight bearing in the upper extremities at week 7 for Carrie was followed by a gradual increasing trend in the number of arm positions emitted per session and was followed by a decreasing trend. The sharp increase at week 34 marked the emergence of crawling during the session. The emergence of extended arm props at week 22 was followed by a low level occurrence of the response between weeks 26-30.

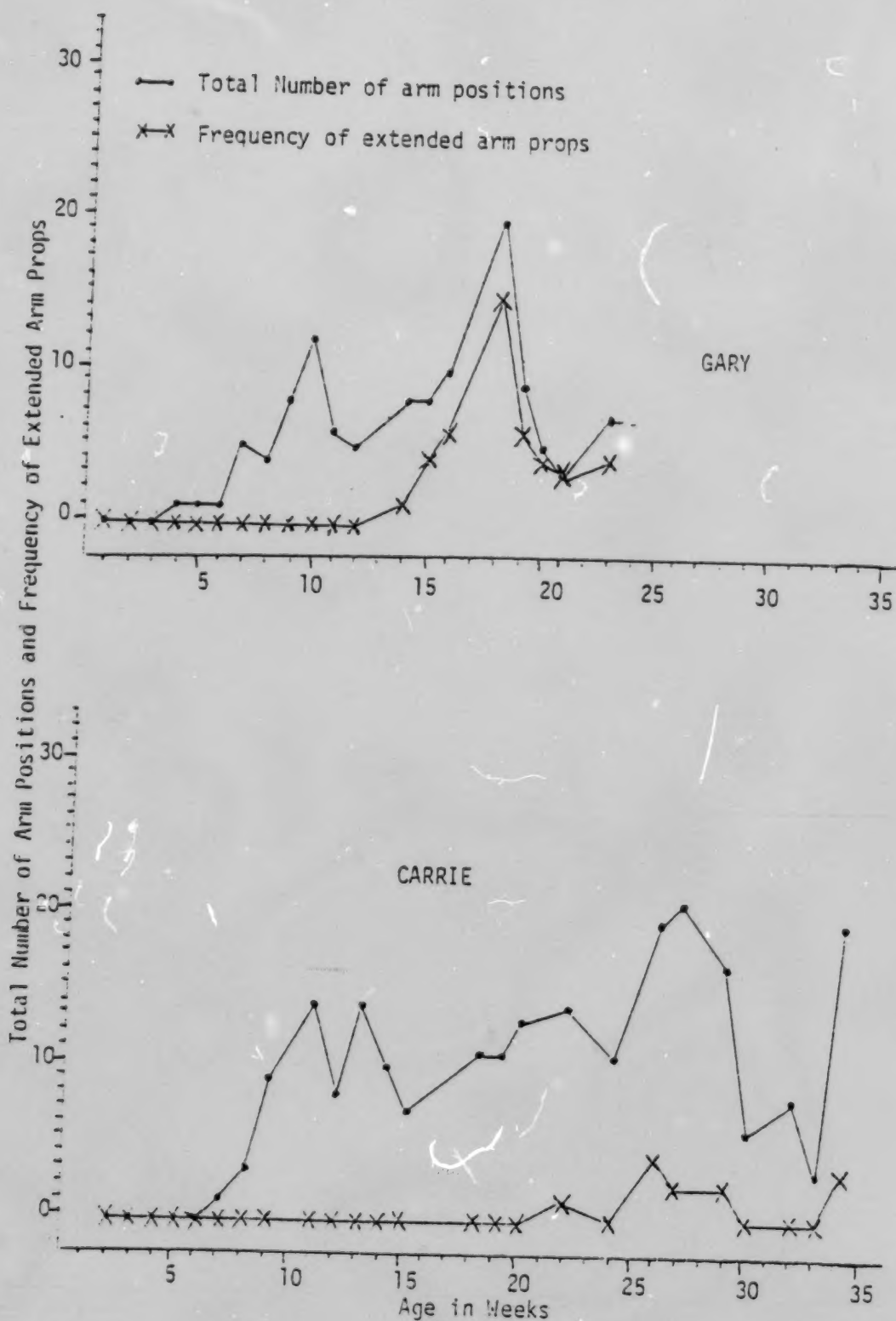


Figure 14. Total number of arm positions and frequency of extended arm props in a 3 minute session for Set 3 in the prone position. Data for both subjects, Gary (upper graph) and Carrie (lower graph) presented by chronological age in weeks.

Figure 15 presents performance data on the cumulative duration of head erect and extended arm props and the duration of the longest head lift for each subject. Performance data on cumulative duration of head erect for Gary indicated an increasing trend. Performance data on the longest head lift paralleled the data on cumulative duration of head erect. Performance data on cumulative duration of extended arm props demonstrated an increasing trend between weeks 14-21. Performance data on cumulative duration of head erect for Carrie indicated an initial low level followed by an increasing trend. Performance data on duration of longest head lift paralleled the data on cumulative duration of head erect. Performance data on cumulative duration of extended arm props indicated that the response was not present until week 34.

Performance data on the frequency of extended arm props and cumulative duration of extended arm props for Gary (see Figure 16) indicated an initial parallel acquisition followed by an inverse relationship between frequency and duration on subsequent weeks. Performance data for Carrie indicated a low level of occurrence of extended arm props between weeks 26-30 with an associated cumulative duration of less than 10 seconds. A cumulative duration of 30 seconds was recorded on the final session.

Figure 17 presents performance data on movement in the position (i.e., head lifts and arm positions). Three phases are illustrated in the graph. In the initial phase a sharp increase in head lifts was followed by a decreasing trend in the occurrence of the behavior. The second phase demonstrated a transition between decreasing head lifts and the emergence of upper extremity weight bearing. In the third phase the frequency of head lifts decreased to one per session accompanied by an increasing trend in the number of arm positions. The final data point

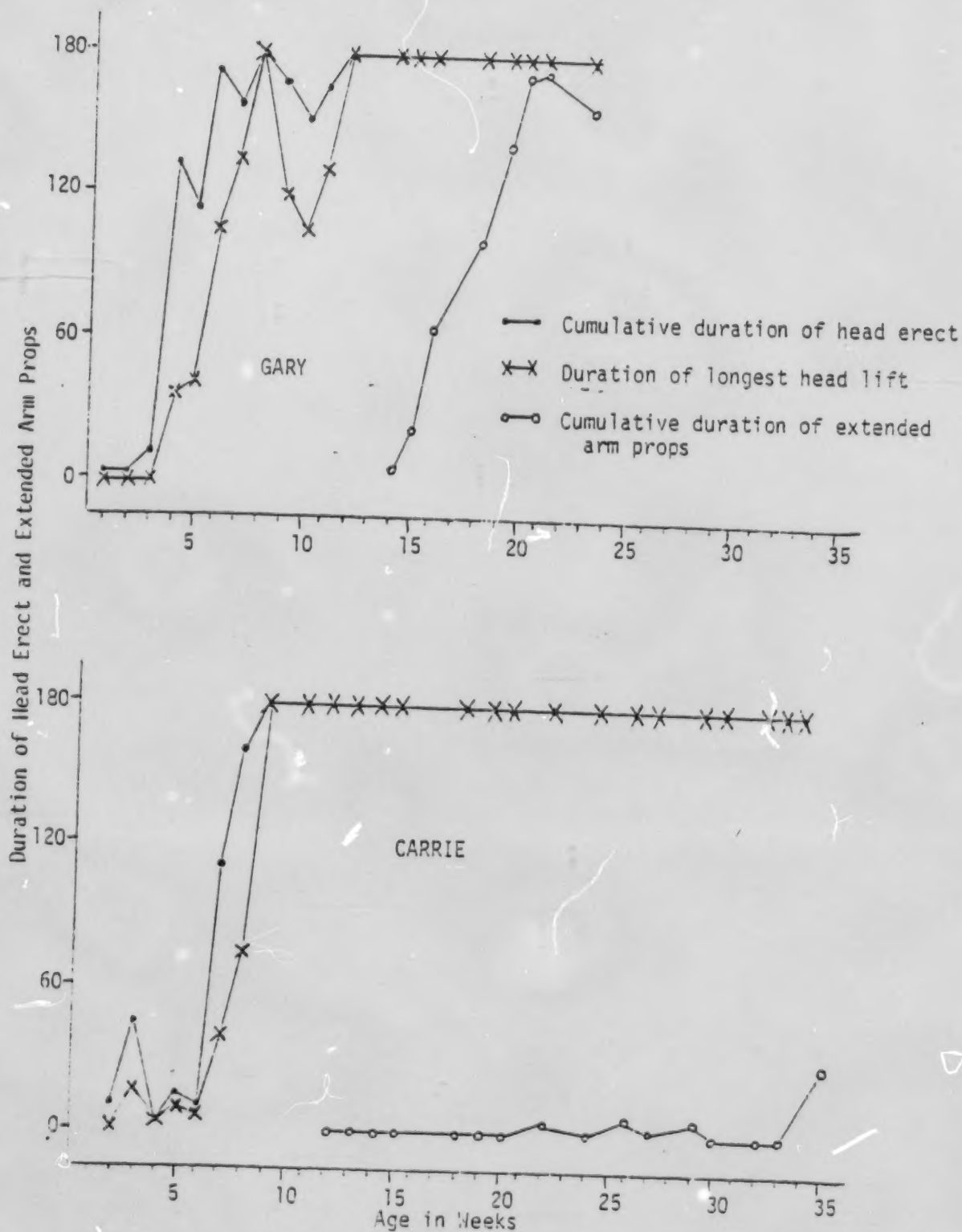


Figure 15. Cumulative duration of head erect, duration of longest head lift and cumulative duration of extended arm props in a 3 minute session for Set 3 in the prone position. Data for both subjects, Gary (upper graph) and Carrie (lower graph) presented by chronological age in weeks.

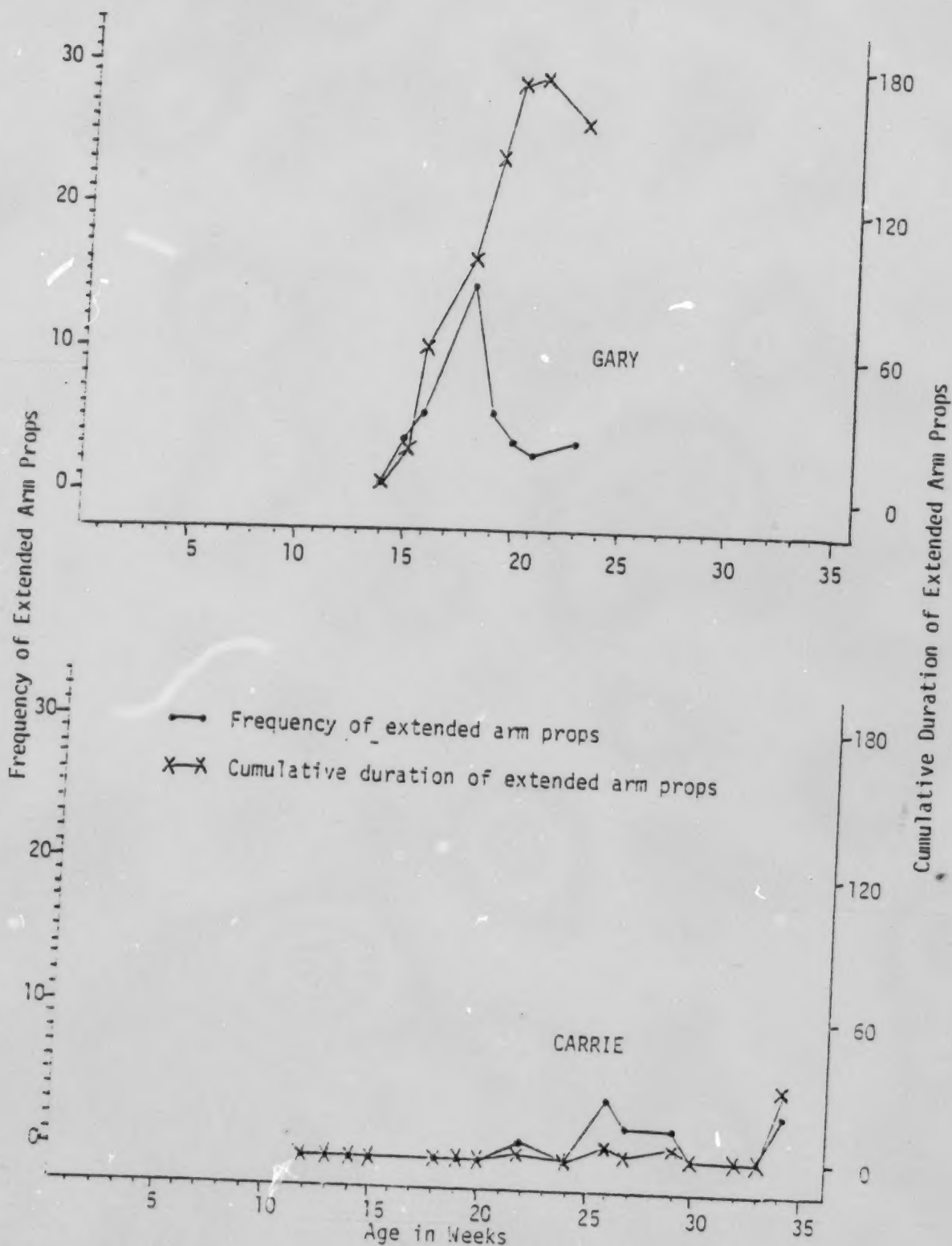


Figure 16. Frequency and cumulative duration of extended arm props in a 3 minute session for Set 3 in the prone position. Data for both subjects, Gary (upper graph) and Carrie (lower graph) presented by chronological age in weeks.

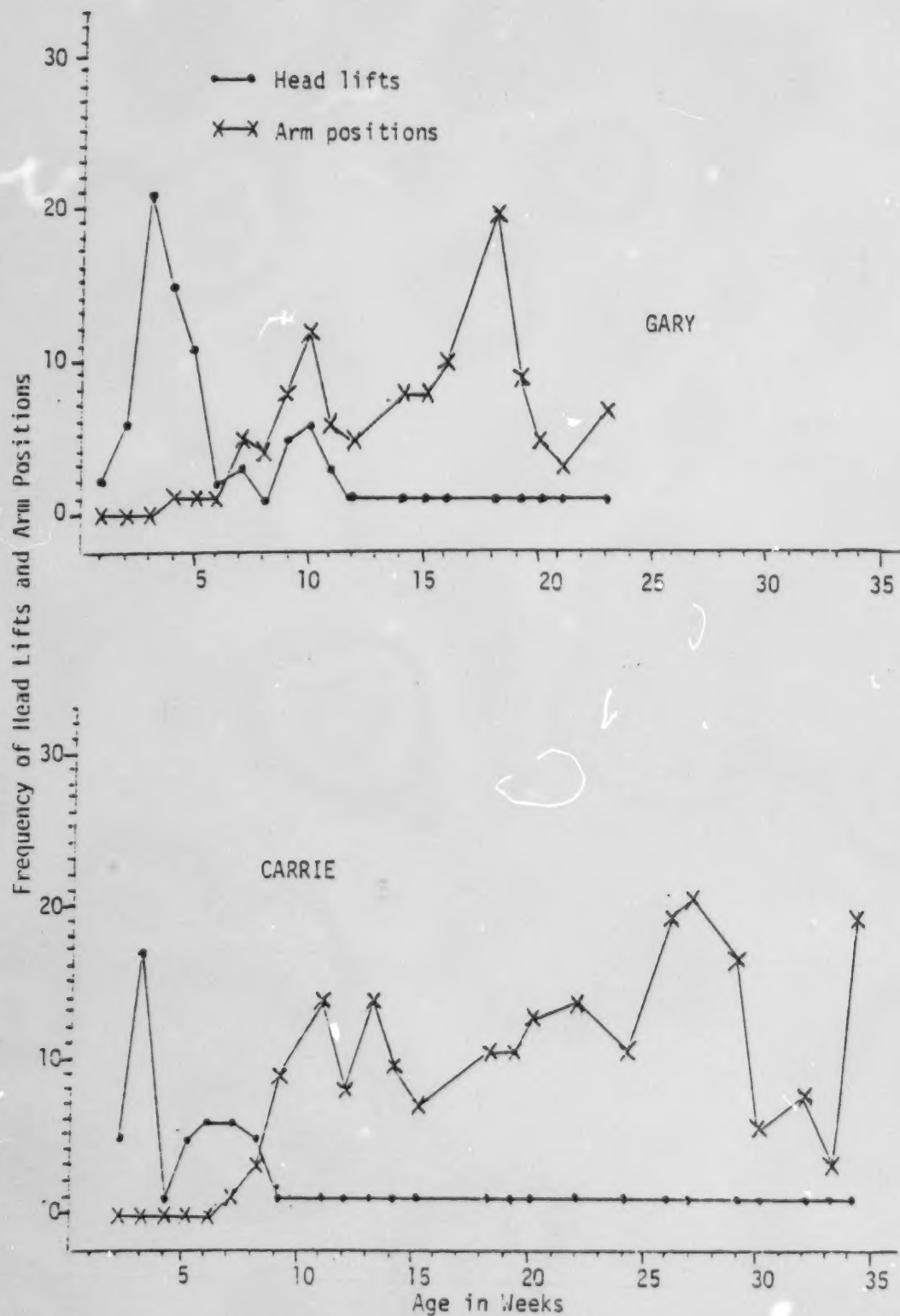


Figure 17. Frequency of head lifts and arm positions in a 3 minute session for Set 3 in the prone position. Data for both subjects, Gary (upper graph) and Carrie (lower graph) presented by chronological age in weeks.

for Carrie demonstrated an abrupt increase which was associated with the emergence of crawling during the session.

First occurrence of behavior descriptors for head erect and upper extremity weight bearing in the prone position for individual subjects and across subjects. Table 21 presents the first occurrence of selected behavior descriptors for head erect and upper extremity weight bearing in the prone position for individual subjects and across subjects. The performance data on the first occurrence of cumulative duration of head erect greater than 90 seconds demonstrated a range of 6-12 weeks and a mean of 9 weeks across subjects. The first occurrence of props on forearms had a range of 4-13 weeks and a mean of 10 weeks across subjects. Duration of longest head lift greater than 90 seconds demonstrated a range of 6-12 weeks with a mean of 9 weeks across subjects. The first occurrence of duration of longest head lift equals 180 seconds indicated a range of 8-13 weeks with a mean of 11 weeks across subjects.

For two consecutive sessions, the duration of longest head lift equals 180 seconds occurred between 1-18 weeks with a mean of 15 weeks across subjects.

Props on extended arms first occurred between 14-22 weeks with a mean of 17 weeks across subjects.

The performance data on the first occurrence of cumulative duration of extended arm props greater than 90 seconds indicated a range of 18-22 weeks with a mean of 19 weeks across subjects.

Discussion

The primary purpose of this study was the revision and longitudinal replication of the quantitative assessment procedures measuring the acquisition of head erect behaviors in the prone and supported sitting positions.

Table 21

First Occurrence of Behavior Descriptors for Head Erect and Upper Extremity Weight Bearing in the Prone Position for Individual Subjects and Across Subjects

Descriptors	Age in weeks for individual subjects						Range	Mean
	1	2	3	4	5	6		
Cumulative duration of head erect > 90 sec.	6	6	12	12	4	7	4-12	7
Props on forearms	13	12	11	12	4	8	4-13	10
Duration of longest head lift > 90 sec.	8	7	12	12	6	9	6-12	9
Duration of longest head lift = 180 sec.	11	16	13	13	8	9	8-13	11
Duration of longest head lift = 180 sec. (for 2 sessions)	16	17	17	18	14	11	11-18	15
Props on extended arms	15	17	18	18	14	22	14-22	17
Cumulative duration of extended arm props > 90 sec.	19	20	22	19	18	-	18-22	19

Results from Reliability Measures

These procedures proved to be reliable in assessing head erect and upper extremity weight bearing in the prone position and head erect in the supported sitting position. The initial targeted behavior in the prone position was head erect. For all head erect descriptors across all sessions the lowest mean reliability for one subject was 90%, and the grand mean was 93%.

Mean reliability for specific behavior descriptors across all subject ranged from 88% - 97%. The behavior descriptor, arm positions, yielded the lowest mean reliability of 84% across all sessions for two subjects. The lower mean reliability scores for arm positions may have resulted from the increase in the number of behaviors that required simultaneous measurement.

Reliability data on the descriptor, head turns, were only presented for the last two subjects. This descriptor was added at the recommendation of a consultant to the study after the first four subjects had been terminated.

The second targeted behavior in the prone position was upper extremity weight bearing. The lowest mean reliability of one subject, for all upper extremity weight bearing descriptors, across all sessions was 90% with a grand mean of 92%.

Mean reliability for specific behavior descriptors across all subjects ranged from 86% - 95%. The behavior descriptor, arm positions, yielded the lowest mean reliability of 84% across all sessions for one subject. The arm position code represented seven possible combinations of arm positions arranged sequentially from no arm support to extended arm props. Disagreements on the code generally occurred in a one-step direction on items that were topographically similar.

Head erect in supported sitting was measured by recording the frequency of head movements in and out of the third trisection and the cumulative duration of head erect. The lowest mean reliability for head erect in supported sitting for one subject, for all supported sitting descriptors, across all sessions was 93% and the grand mean was 93%. Mean reliability for specific behavior descriptors across all subjects ranged from 91% - 96%.

A conservative approach was employed in the initial computation of reliability scores for the arm position code. Although there were seven possible descriptors for arm position, only agreement/disagreement on the occurrence of a descriptor (i.e., agreement on code) was computed in determining the reliability for each session. The inclusion of non-occurrence data, particularly for the second and fourth phase, would have resulted in higher reliability scores for the arm position code. This approach was not employed because it did not accurately reflect the agreement on individual arm movements represented in the code.

Reliability was recomputed to determine the agreement of the observers across all arm positions (i.e., agreement on frequency) emitted by the subject per session. This resulted in an increase in mean reliability scores across subjects. The overall mean reliability for agreement on the occurrence of individual arm position (i.e., agreement on the code) was 86%; the overall mean reliability for agreement across all arm positions (i.e., agreement on frequency) was 91%.

Results from Performance Data

Prone position. The revised assessment procedures provided information on precise quantification of present skill level, rate of acquisition and covariations in emerging behaviors. Simultaneous quantification of

frequency of head lifts, duration of longest head lift and cumulative duration of head erect resulted in measures sensitive to subtle differences in the emergence and rate of acquisition of head erect behavior. Table 21 presented the first occurrence of selected behavior descriptors for head erect and upper extremity weight bearing in the prone position for individual subjects and across subjects. These data further demonstrated the sensitivity of the procedures in precisely quantifying present skill level. Although similarities were evident within pairs of twins, the assessment indicated subtle differences in emergence and acquisition of specific motor behaviors and successfully demonstrated different ages for acquisition of mobility (i.e., creeping) in the prone position.

An analysis of the performance data demonstrated several trends in acquisition across subjects. A sequential presentation of these trends included: (1) a decrease in head lifts associated with an increase in cumulative duration of head erect, (2) stabilization of head lifts at one per session associated with an increase in frequency of arm positions, (3) an increase in frequency of arm positions preceded and coincided with the emergence of extended arm props, and (4) a decrease in frequency of arm positions associated with an increase in cumulative duration of extended arm props. With the exception of Carrie, who did not acquire extended arm props, these trends were evident. Although the age of occurrence varied across subjects, the single infants consistently demonstrated an earlier age of emergence when compared to the pairs of twins. Within and between pair comparisons of twins generally showed more concordance than comparisons of twins with single infants for age of occurrence.

These trends also allowed for an analysis of the interaction of stability vs. mobility in the prone position. The interactive effect of these two postural mechanisms on covariations in emerging behaviors was suggested by the following phases: (1) stability of head erect preceded movement in the position (i.e., arm positions), (2) emergence of movement had a brief negative effect on the stability of the head erect response, (3) reacquisition of stability was followed by a sharp increase in movement, (4) movement decreased as stability of extended arm props of forearm props (for Carrie) was acquired, and (5) stability of extended arm props or forearm props (for Carrie) preceded the emergence of mobility in the prone position (i.e., crawling or creeping).

These interactions between stability and mobility, clearly differentiated in the performance data, resulted from revisions in the original procedures which allowed for the simultaneous measure of two interrelated behaviors (i.e., head erect and upper extremity weight bearing).

Supported sitting position. The revised procedures for this position resulted in less definitive data on the emergence and acquisition of head erect behavior. Although, generally consistent patterns of acquisition were demonstrated across condition changes and across subjects (i.e., as stability of head erect was acquired, frequency of head movements decreased and/or cumulative duration increased), the criteria for a condition change was often based on clinical judgement. Reliance on the performance data for criteria was difficult when any one of the following trends occurred: (1) an increase in frequency associated with high levels of cumulative duration, (2) a decrease in frequency associated with a decrease in cumulative duration, and (3) an increase in frequency

associated with a decrease in cumulative duration resulting from voluntary movements of the subject.

In addition, the sequential fading of the external support in a cephalo-caudal direction resulted in an actual assessment of both head and trunk control. The procedure was most effective for monitoring head erect in the first 2-3 conditions. During these condition, head erect behavior was the targeted skill and the confounding influence of the emergence of trunk control was minimized. The number of personnel required (i.e., two to four) contributed to logistical problems in the longitudinal application of this procedure.

Implications for Future Research

Longitudinal tracking of the acquisition of behaviors in the prone position will require that future research systematically address the differences in the various sensory/motor assessment procedures (i.e., head erect, rolling, crawling and creeping). Minimizing the differences in the procedures will allow for ease in transition between tools, and provide a basis for comparison of acquisition and covariations across behaviors in the prone position. Similarly, future research efforts should be directed at combining the procedures for measuring head erect in supported sitting with the procedures for measuring sitting.

The clear interactions between stability and mobility in the prone position warrant further longitudinal data collection on handicapped and nonhandicapped infants. These preliminary results suggest that assessment of at-risk infants requires simultaneous tracking of head erect and upper extremity weight bearing behaviors. In addition, longitudinal research will determine the sensitivity of the procedure in detecting different trends and topographies in the motor development of handicapped

infants. Movement in the position, monitored by frequency of head lifts and arm positions, may provide an early quantitative differentiation between different types of handicapping conditions (e.g., hypotonia, spasticity, athetosis) as well as the degree of motor involvement in each upper extremity.

Monitoring the effects of early intervention efforts is a significant area of application that warrants further investigation. Continuous application of the procedures will yield information on precise quantification of present skill level and rate of acquisition. In addition, the procedure can be used to evaluate and/or compare the various therapeutic techniques employed to facilitate the acquisition of head erect and upper extremity weight bearing behaviors in a handicapped population.

A REPLICATION STUDY:
Revised Procedures for the Quantitative Measurement of
Sitting Behavior in Handicapped and Nonhandicapped
Infants and Children

by
Catherine Thompson
and
Jane P. Rues

¹The procedures and data reported in this study were taken from a master's thesis by Catherine Thompson that was submitted to the Department of Special Education, University of Kansas, in 1980.

Overview of Measurement Procedures

The original procedure for measuring sitting behavior included the following tests: (1) measurement of supported sitting, (2) measurement of propped sitting, (3) measurement of independent sitting, (4) measurement of come-to-sit from supine using trunk rotation, (5) measurement of come-to-sit from sidelying, (6) measurement of come-to-sit from supine using trunk flexion, (7) measurement of protective extension to the side and (8) measurement of protective extension to the back.

The first three tests, measuring supported, propped and independent sitting, were combined into a single tool entitled stability: cumulative duration. Revisions of these tools included reducing the number of data sheets for three to a single data sheet and designating the amount of support required by the subject on the data sheet at the beginning of each trial. An additional revision of these measures was the reduction of the amount of time between time checks (i.e., the time for observing the subject's posture for data collection) from every 30 seconds to every five seconds for a more sensitive record of the subject's sitting behavior. The assessment tool for sitting stability required the least amount of revision.

A major revision was made in the measurement of coming-to-sit from supine and from sidelying. The initial assessment tool included measuring coming-to-sit from supine using trunk flexion and coming-to-sit from supine using trunk rotation. The revised assessment tool eliminated come-to-sit from supine using trunk flexion because it is not a skill which develops before or concurrently with sitting. This measure added little information regarding the development of sitting.

Coming-to-sit from supine using trunk rotation and coming-to-sit from sidelying were similar tools. The revised procedure eliminated the measurement of come-to-sit from supine using trunk rotation to avoid redundancy in assessment. The final revision had one measure of coming-to-sit, starting the measurement with the subject positioned in sidelying. To further aid in the identification of the emergence of this skill, a sequence of physical prompts were provided in a prescribed fashion for each subject.

This final revision incorporated the same basic definitions as the original measure for coming-to-sit behaviors, however, a code was utilized to collect data more efficiently. Two trials were used to measure the occurrence of come-to-sit behavior.

The procedures for the measurement of protective extension forward and protective extension laterally were completely revised to eliminate the stimulus used in the original study to elicit a protective response. The original measure positioned the subject on an inclined mat with the subject's down side supported by a board. With removal of the board (the stimulus) a protective response was to be elicited. This measure was very stressful to the subject who could not exhibit a full protective response. A gentle push forward or laterally, further distinguished by the speed of the forward or lateral displacement, was the stimulus for the revised measure of protective extension forward and protective extension laterally. A list of response definitions from movement at the shoulder to the position of the hand was devised for the new measure. The number of trials was reduced from five to three per session which increased the probability that the response was automatic or reflexive rather than learned.

The revised measure added two additional assessment tools to further examine sitting behavior. A measure of the subject's postural symmetry in sitting provided information regarding (1) the subject's stability in sitting, and (2) the presence of asymmetrical posturing of the head and trunk. This measure of asymmetry was included to determine if it was reliable in early identification of asymmetry, important for the detection of structural problems in posture. A single trial of four to twelve time checks (15 seconds each) provided frequency data on the asymmetry in the sitting position.

The second addition was the procedure to assess postural fixation forward and postural fixation laterally. These reflexes contribute to the stability of the subject in sitting. This measure utilized the same stimulus as protective extension, viz., a gentle displacement of the subject's shoulders either forward or laterally. This stimulus was applied at a slower speed to elicit righting reactions of the subject's head and trunk. Response definitions were devised to analyze a wide range of responses. An additional provision included the response of protective extension to indicate that either: (1) the stimulus was too fast or too forceful or (2) the subject had developed an adequate protective response, but had not developed adequate postural fixation.

The revised measures viewed sitting as having three aspects: (1) the structural base of sitting, (2) the reflexive base of sitting and (3) mobility into sitting. The three aspects were assessed by separate tools.

STRUCTURAL BASE

The structural base of sitting was assessed by measuring both the asymmetry of the sitting posture and the stability of the sitting posture.

These two aspects of the structural base were measured by separate tools: (1) Stability: Asymmetry, which measured the asymmetry of head and shoulder positions over time, and (2) Stability: Cumulative Duration, which measured the anterior trunk displacement in sitting over time.

Stability: Asymmetry

This tool assessed the asymmetry of head and shoulder position in sitting, viewing the subject anteriorly. A discrepancy of two centimeters or more between the ear positions or shoulder positions was considered an asymmetrical position. Additional components in this measurement indicated whether the subject was "static" in his posture (i.e., the subject did not change his position for the entire trial) or the subject was "dynamic" in his posture (i.e., he changed sitting position at least once).

Materials and Equipment

The materials and equipment used for this assessment included a data sheet (Figure 1), pencil, posture grid, back support, floor mat, and timing device. Specifications for each piece of equipment are listed below.

Posture grid. A clear plexiglass sheet (measuring three feet wide and four feet high) was used for the posture grid. Strips of colored adhesive tape were placed on the plexiglass sheet horizontally, a distance of two centimeters apart from the top to the bottom of the grid. Two contrasting colors of tape (yellow and red) were used to improve the visibility of the lines; alternating the different colors every other strip was used to improve the contrast. An additional red strip marked the middle of the plexiglass on the vertical axis, separating the right and left sides of the posture grid. The plexiglass was mounted on a wooden frame (see Figure 2).

Stability: Asymmetry

SUBJECT _____ EXAMINER _____
 DATE _____ PHASE _____ OBSERVER _____
 REINFORCER _____ RELIABILITY _____

DIRECTIONS: Every 15 seconds note the following:

- (1) Ear position: What is the ear position?
 R ... the right side is higher
 L ... the left side is higher
 = ... both ears are equal in height (within 1 cm)
- (2) Shoulder position: What is the shoulder position?
 R ... the right side is higher
 L ... the left side is higher
 = ... both shoulders are equal in height (within 1 cm)
- (3) Sitting position: In what position is the subject sitting?
 Ring: legs are not crossed in any manner
 Tailor: legs are crossed in some manner
 Supported: the subject is supported externally by a person or object
 Propped: the right hand or elbow is weight-bearing
 the left hand or elbow is weight-bearing
 both hands or elbows are weight-bearing
 Independent: both hands are non-weight-bearing and there is no support provided to the subject

TIME	STARTING POSITION NOTE: - / - =	RING SITTING		TAILOR SITTING		R
		SUPPORTED	PROPPED	INDEPENDENT		
0 sec	Ear					
	Shoulder					
15 sec	Ear					
	Shoulder					
30 sec	Ear					
	Shoulder					
45 sec	Ear					
	Shoulder					
60 sec	Ear					
	Shoulder					
1:15	Ear					
	Shoulder					
1:30	Ear					
	Shoulder					
1:45	Ear					
	Shoulder					
2:00	Ear					
	Shoulder					
2:15	Ear					
	Shoulder					
2:30	Ear					
	Shoulder					
2						

Figure 1. Data sheet for stability: asymmetry.

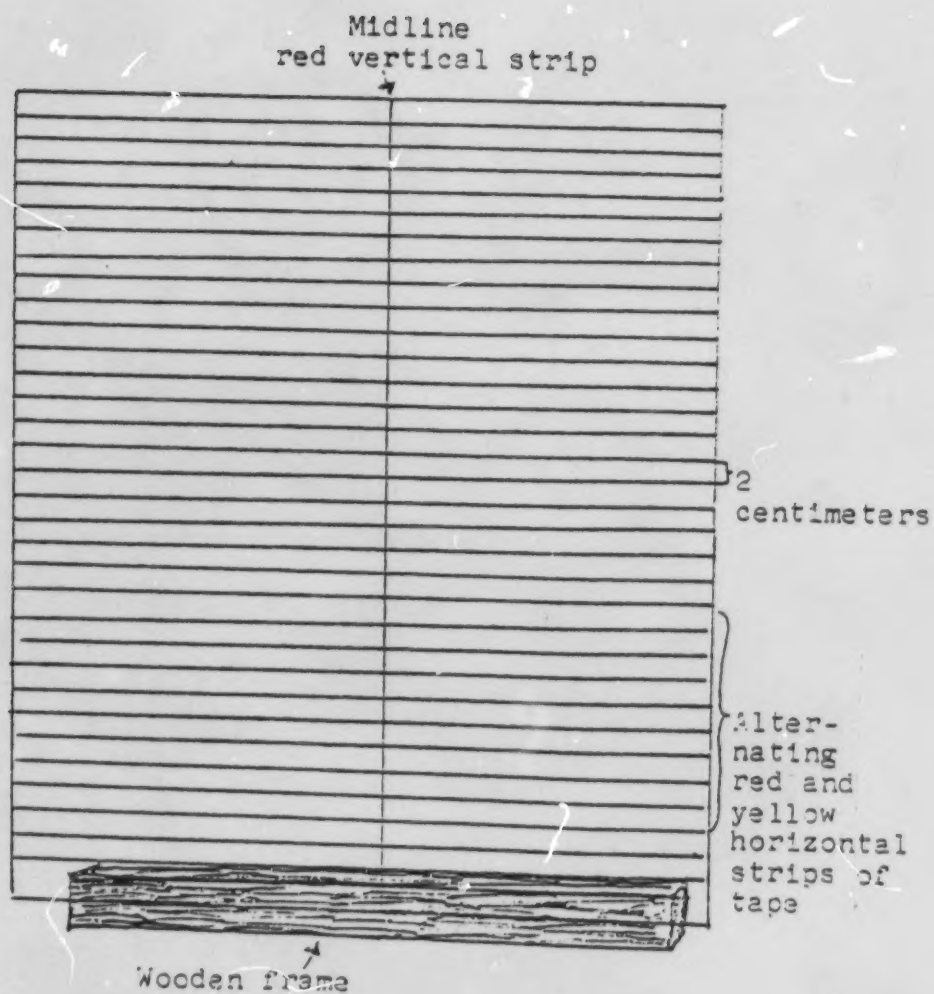


Figure 2. Posture grid for stability: asymmetry.

Back support. A tumbleform (measuring three feet wide by two feet deep by one foot high) provided back support for subjects requiring external support when placed in a sitting position. The back support was placed behind the subject to provide support to the lower back (thoracolumbar region) (see Figure 3).

Floor mat. A slightly padded vinyl floor mat, measuring four feet wide by six feet long, was used for the subject's safety and comfort (see Figure 3).

Timing device. A tape recorder with prerecorded time checks every 15 seconds for two minutes and 30 seconds was used. A time recording signified each time check from a statement "now" at 0 seconds to a statement "two minutes 30 seconds."

Initial Position of the Child

The position selected for each subject was determined on the basis of parent report and by observation of the most symmetrical and stable sitting posture for the subject. Lower back support was provided using the tumbleform or an additional person to support the subject posteriorly, if the subject sat less than three minutes. The sitting positions were defined as follows:

Ring sitting. The subject was positioned in sitting with his knees flexed and abducted (or apart) so that the legs formed a circle in front of the subject (see Figure 4).

Tailor sitting. (Indian-style). The subject was placed in sitting with his feet or lower legs crossed on his knees apart (see Figure 4).

Propped sitting. One or both of the subject's hands or elbows were weight-bearing (making an indent on the floor mat or pressing on the knees) for more than five seconds (see Figure 4).

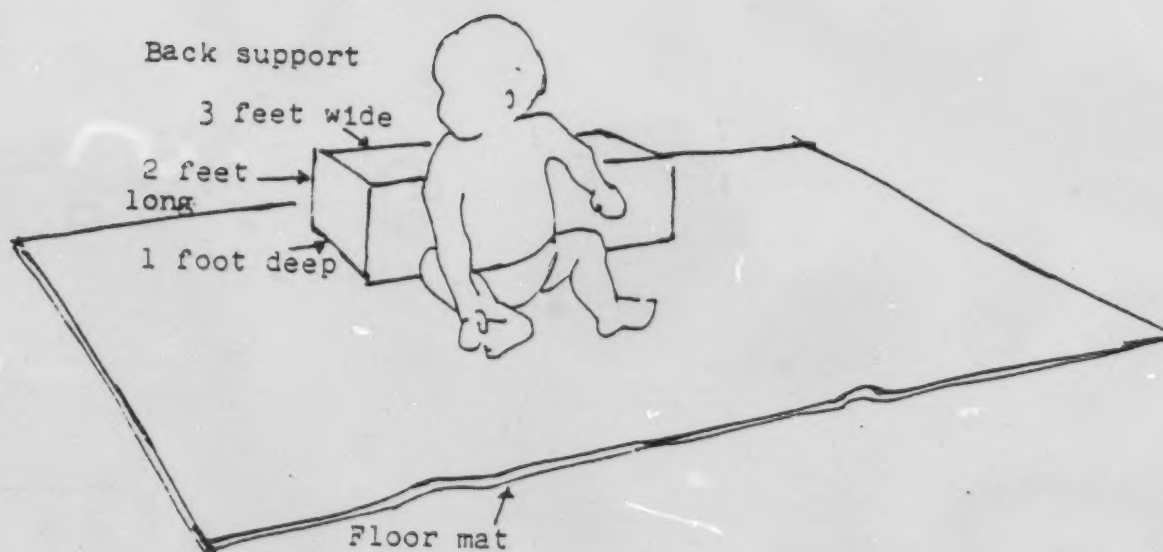


Figure 3. Back support and floor mat for stability measures.



a. Ring sitting



b. Tailor sitting



c. Supported sitting



d. Propped sitting



e. Independent sitting

Figure 4. Definitions of sitting positions of the subject.

Independent. Both hands or elbows were non-weight bearing and there was no support provided to the subject (see Figure 4).

Position of the Materials and the Equipment

After the subject's top clothing was removed, the child was placed directly behind the grid on the floor mat so that the vertical line on the posture grid bisected the subject into right and left halves, and the subject directly faced the examiners (see Figure 5).

Measurement System

The assessment tool defined asymmetry of sitting posture as a discrepancy of two centimeters or more in ear position or shoulder position as viewed anteriorly through a grid. Specifically, positions of the ear and shoulder were defined as follows:

Ear position. The ear position was measured by looking at the top of the ear. The ears were considered equal if the top of both ears fell within a two centimeter horizontal segment on the posture grid. An equals sign (=) was the code used to signify equal ear positions. An equals sign was also marked if the subject turned his head, obscuring the view of both ears. An "R" was the code to indicate that the subject's right ear was higher and an "L" was the code to indicate the subject's left ear was higher (see Figure 6).

Shoulder position. The same coding system used for ear position was used for shoulder position, using the top of the shoulders as a reference point. An equals sign (=) signified a discrepancy of less than two centimeters or an obscured view of both shoulders; an "R" designated that the top of the subject's right shoulder was higher; and an "L" designated that the top of the subject's left shoulder was higher (see Figure 6).

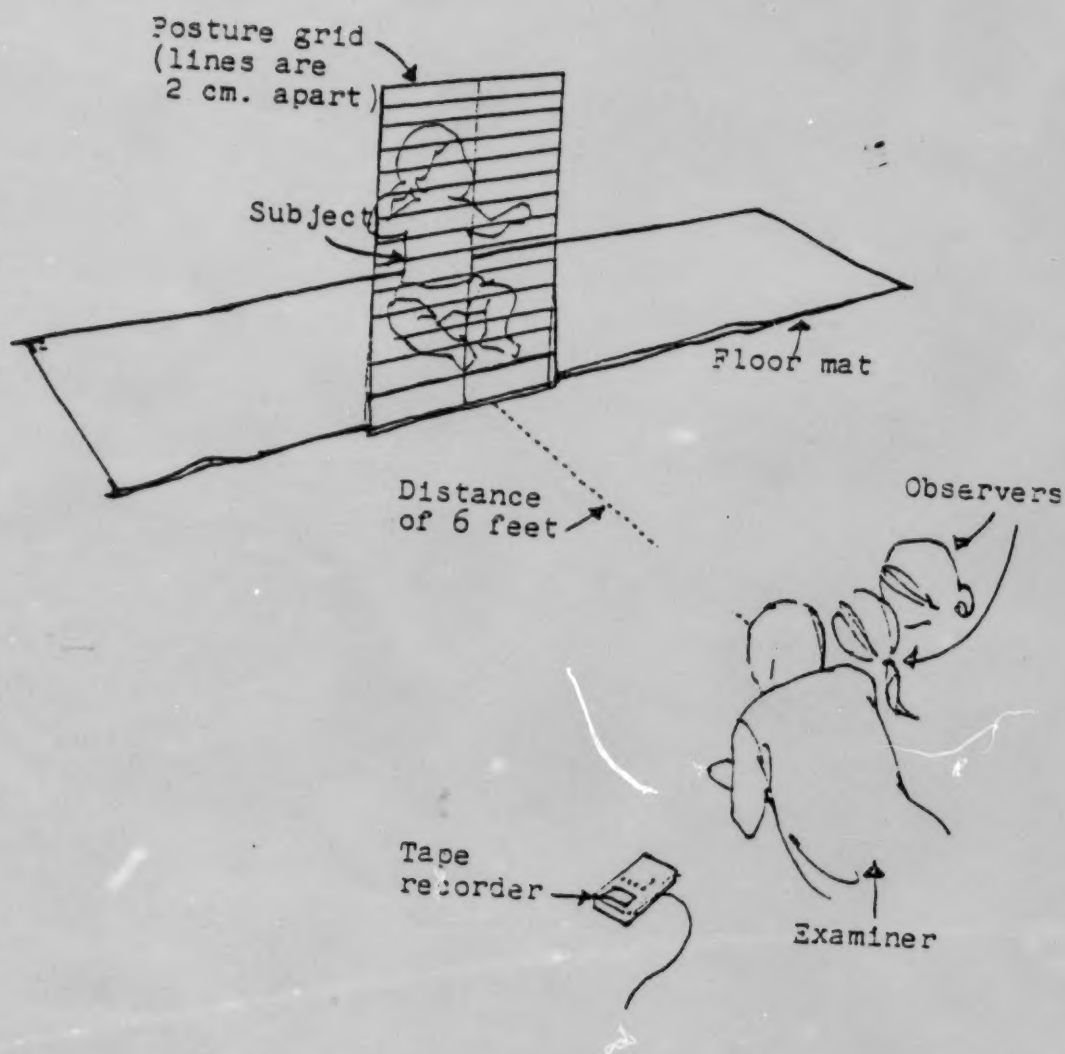
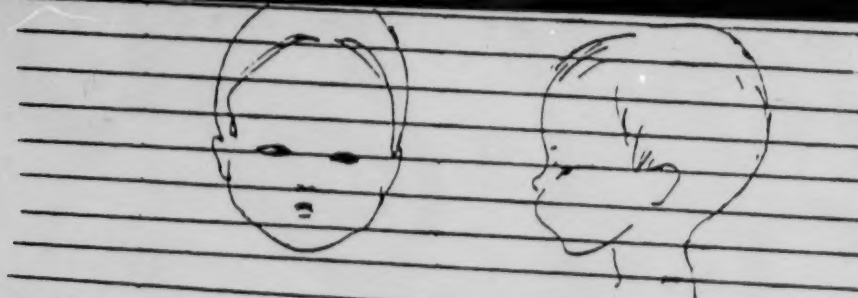
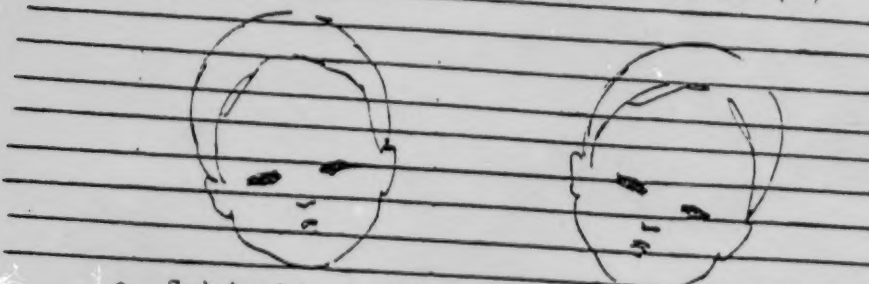


Figure 5. The examiner and observers viewing the subject.

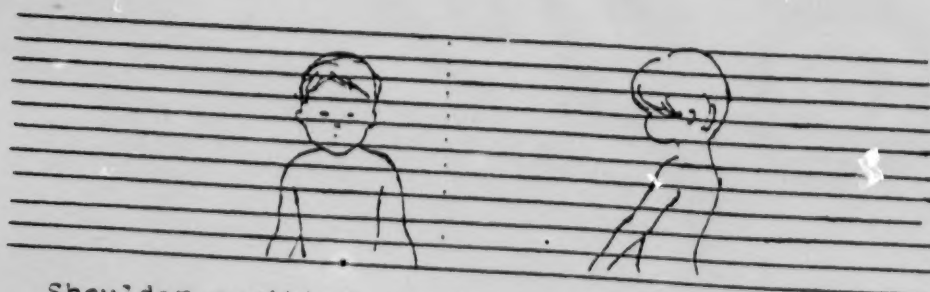


Ear position:

- a. Top of the ears are equal (=) b. One of the ears is obscured (=)

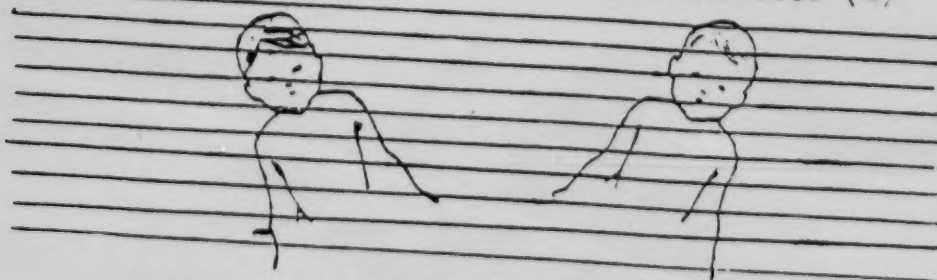


- c. Subject's left ear is higher (L). d. Subject's right ear is higher (R).



Shoulder position:

- a. Top of the shoulders are equal (=) b. One shoulder is obscured (=)



- c. Subject's left shoulder is higher (L) d. Subject's right shoulder is higher (R)

Figure 6. Definitions of ear position and shoulder position.

Procedures for Measurement

1. The subject and the observers were positioned appropriately.
2. The examiner or an additional person presented the subject with a reinforcer (food or toy) when the subject looked through the posture grid with the vertical line bisecting his head.
3. The tape recorder was turned on for the initial time check. If the subject fell from sitting prior to the beginning of the trial or prior to 45 seconds, the subject was repositioned to start a new trial. Back support was provided if it had not been provided previously. The subject was repositioned if falling occurred during the trial after the minimum of 45 seconds had passed.
4. The data sheet was marked in the appropriate row and column for each time check. The trial was discontinued if the subject became non-compliant or fell and did not regain a sitting posture without assistance within 10 seconds.

One three-minute trial was run per session unless the subject was unable to maintain sitting for four time checks (45 seconds) in which case an additional trial was run or an additional session was arranged for collecting data.

Marking the Data Sheet

Starting with "now" at 0 seconds on the tape recorded statement, the examiner and the observer noted the starting position of the subject. At each 15-second interval, signified by the tape recorded time check, the examiner and the observers marked the code for ear position and shoulder position under the column which designated the amount of support used by the subject in sitting. The change in column would indicate whether the subject was static or dynamic in his sitting position.

Computing the Results

The data sheet contained information regarding the subject's stability:

(a) the asymmetry of the subject's sitting posture and (b) the change of the subject's posture over time. These two descriptors included:

a. Asymmetry: The asymmetry of the ear position and the shoulder position were calculated separately. The total number of L's (number of occurrences) was divided by the number of time checks (total possible number of occurrences) for the percentage of asymmetry for either ear position or shoulder position. See the example below:

ear position	4 L's	5 R's
shoulder position	4 L's	0 R's

(in a total of 10 time checks)

Use the following equation:

$$\frac{\# \text{ of occurrences}}{\# \text{ of possible occurrences}} = \text{Percentage of asymmetry.}$$

Therefore,

$$\frac{4 \text{ L's}}{10 \text{ time checks}} = 40\% \text{ asymmetry of left side ear position and shoulder position, and}$$

$$\frac{5 \text{ R's}}{10 \text{ time checks}} = 50\% \text{ asymmetry of right side ear position.}$$

b. Static or dynamic: A subject was considered "static" if he or she did not change columns (e.g., changing from the column marked "supported sitting" to "independent sitting") during the entire trial. If the child did change columns, then sitting was considered "dynamic."

Specifications for Taking Reliability Measures

Reliability for each trial was determined by comparing the results of each observer for each descriptor to those of the examiner. The reliability was calculated as follows:

$$\frac{\# \text{ of agreements}}{\# \text{ of disagreements} + \# \text{ of agreements}} \times 100 = R. \\ (\text{overall reliability})$$

Stability: Cumulative Duration

The ability to maintain the sitting position and to demonstrate an erect back posture were the targeted behaviors in the assessment of stability. The ability to maintain sitting or the duration of sitting was measured in five second checks for up to three minutes. The back posture of the child was measured in terms of the trunk's deviation from the vertical plane as the subject was viewed from the side.

Materials and Equipment

The materials and equipment included a plexiglass trisection, back support (optional), timing device, floor mat, adhesive marker, and data sheets (Figure 7). Following are the specifications for each piece of equipment:

Plexiglass trisection. A 24-inch high by 24-inch wide clear plexiglass sheet was used. Strips of red adhesive tape divided the plexiglass into three 30-degree angles. This plexiglass was mounted on a wooden frame for support. The trisections were numbered I, II and III, with I encompassing the length of the vertical edge, II in the middle, and III encompassing the length of the horizontal edge (see Figure 8).

Back support. Refer to Materials and Equipment under Stability: Assymetry.

Timing device. A prerecorded tape with time checks stated every five seconds for three minutes was used.

Floor mat. Refer to Materials and Equipment under Stability: Assymetry.

Adhesive marker. A one-inch adhesive circle was placed on the subject's shoulder (i.e., one inch below the acromion process and centered over the deltoid muscle) as a reference point (see Figure 9).

STABILITY: CUMULATIVE DURATION

SUBJECT _____ EXAMINER _____

DATE _____ PHASE _____ OBSERVER _____

REINFORCER _____ RELIABILITY _____

DIRECTIONS: A. Note the SHOULDER POINT in relationship to the trisection in which it falls. View the SHOULDER POINT from a distance of 6 feet directly lateral to the subject's hips and perpendicular to the trisection measuring instrument. B. Mark below the following: (1) Each time the shoulder point changes trisection for more than 5 seconds. (This excludes reaching for toys). C. Time the following: (1) The total duration of the trial (minimum of 45 seconds, maximum of 3 minutes). (2) The total time that the subject's shoulder point is in Trisection I. (On Tape)

POSITION OF THE SUBJECT: _____

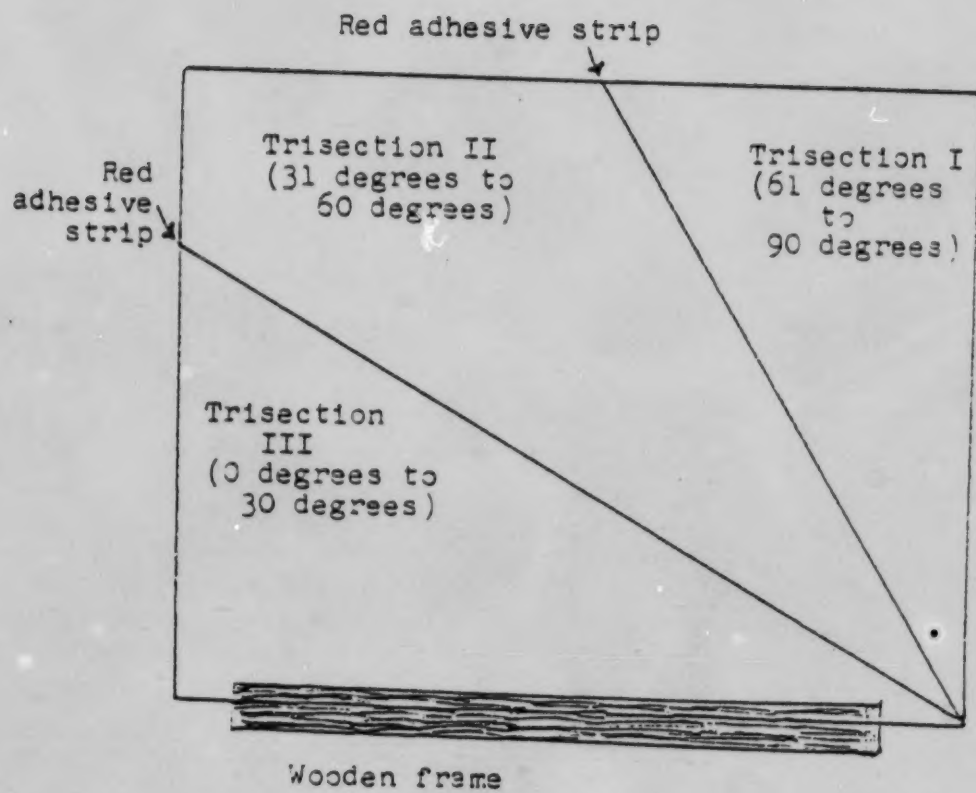
SIDE OF THE SUBJECT VIEWED: _____

TRISECTIONS:		TRISECTIONS:			
		I	II	III	R
VIEWING FROM THE:					
RIGHT	LEFT				
					
RELIABILITY					

Total Time of the Trial: _____

Cumulative Duration in Trisection I: _____

Figure 7. Data sheet for stability: cumulative duration.



320

Figure 8. Plexiglass trisection for stability: cumulative duration.

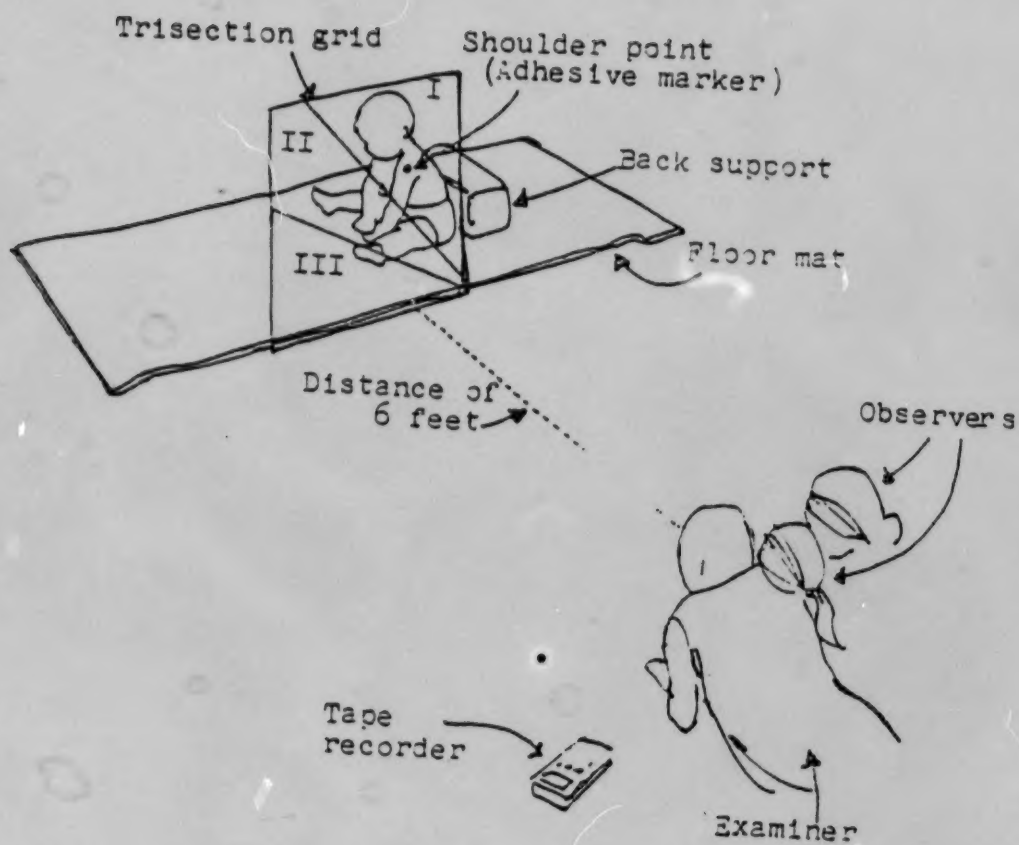


Figure 9. The examiner and observers viewing the subject.

Initial Position of the Child

Refer to the sitting positions defined in the measure of Stability: Assymetry. After the subject's top garments were removed, the subject was placed on a mat so that the left or right side faced the examiner. An adhesive marker was placed on the center of the subject's shoulder. The subject's back was aligned with the vertical edge of Trisection I. Visual distractors were placed directly in front of the child at a height which would encourage the child to sit erectly (see Figure 10).

Measurement System

The following terms were used in this assessment.

Position of the subject. This referred to the sitting position of the subject, either ring sitting or tailor sitting and the support provided. See the definitions of sitting positions described in Initial position of the child under the section Stability: Assymetry.

Anterior trunk displacement. The angle of trunk displacement was measured by recording the duration that the subject's shoulder (i.e., designated by adhesive marker) was contained in each trisection. The subject was viewed laterally; the subject's right side was designated "right view," the left side was designated "left view" (Figure 11).

Procedures for Measurement

1. The subject and the observers were positioned appropriately.
2. The examiner and the observers noted the initial sitting position of the subject and the support provided on the data sheet.
3. After the tape recorder was turned on to its initial time check, the trial began. Starting with the recorded statement, "Begin now," the examiner and the observer noted on the data sheet the trisection that contained the subject's shoulder (i.e., adhesive marker).

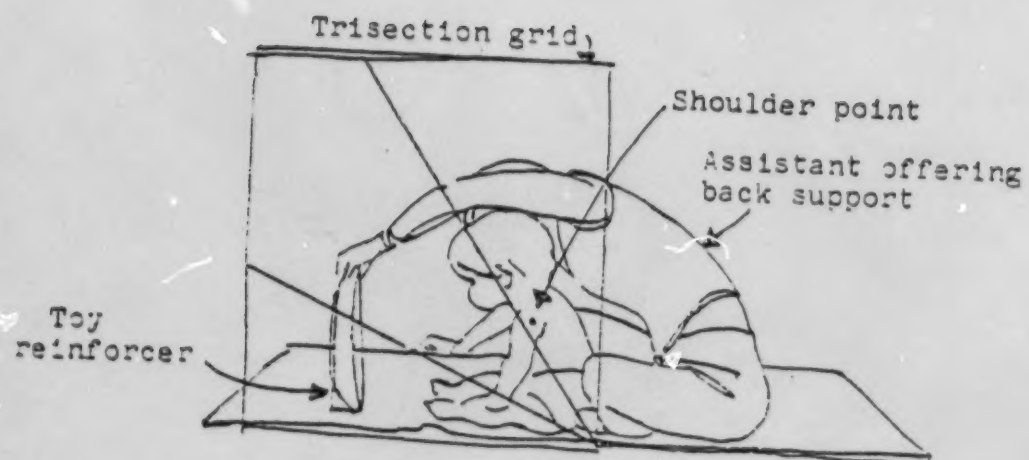
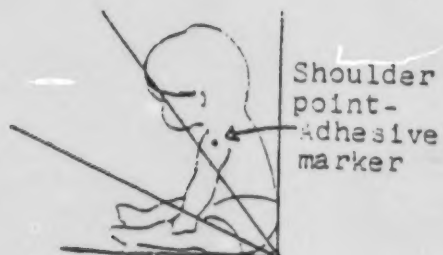
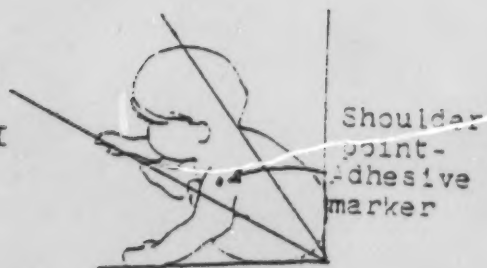


Figure 10. Visual distractor held by the assistant.

a. Sitting in Trisection I



b. Sitting in Trisection II



c. Sitting in Trisection III

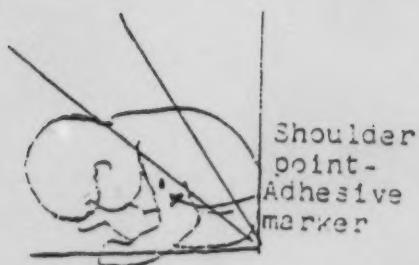


Figure 11. The shoulder point viewed through trisections I, II, and III.

4. In each subsequent time check the examiner and the observers recorded the trisection in which the subject's shoulder was contained. The duration of the trial was at least 45 seconds and, at most, three minutes. Reaching for objects did not constitute a change in trisection if the subject returned to the prior trisection within five seconds.

One trial per session was conducted.

Computing the Results

The cumulative duration in each trisection was calculated by multiplying the number of slashes in each trisection (i.e., Trisection I, II, or III) by five seconds (for each time check). The cumulative duration for the trial was the sum of the cumulative duration measures for each trisection.

Specifications for Taking Reliability

Refer to this section under Stability: Asymmetry for the computation of reliability.

REFLEXIVE BASE

The reflexive base of sitting was assessed by measuring the responses elicited for two reflexes which are developmental prerequisites to independent sitting. The two reflexes are: (1) protective extension of the upper extremities, forward and laterally; and (2) postural fixation in sitting, forward and laterally.

Protective Extension

Forward and lateral protective extension were measured in response to both slow and quick displacement of the shoulder in the appropriate direction. A code was developed which defined a wide range of responses in the upper extremities to both stimuli and direction.

Materials and Equipment

The assessment of protective extension required a floor mat, mirror, and data sheet (see Figure 12).

Mirror. A freestanding mirror (measuring six feet high and three feet wide) was used.

Initial Position of the Subject

The subject was positioned either ring sitting or tailor sitting in the center of the floor mat (see the sitting positions under Initial position of the child, Figure 4). To optimally observe the subject's protective responses, the examiner relaxed the subject's arms in his or her lap (the elbow extended less than 60 degrees). Support, as needed, was given to the subject by the examiner who was positioned behind the subject.

Position of the Materials and the Equipment

A mirror was placed two feet directly in front of the subject and the examiner so that the examiner could clearly observe the movements of the subject (see Figure 13).

Position of the Observers

Each observer was positioned in sitting on either side of the mirror, facing the subject and the examiner (see Figure 13). The view of each observer was checked for clear visibility prior to beginning each trial.

Measurement System

Following are the stimulus definitions used for the protective extension measures. The same definitions were used for both directions of the stimuli (i.e., forward or laterally).

Quick stimulus. The examiner displaced the subject's shoulders forward (laterally) 30 degrees within one second. The examiner did not

REFLEXIVE BASE: PROTECTIVE EXTENSION AND POSTURAL FIXATION

SUBJECT _____ EXAMINER _____

DATE _____ PHASE _____ OBSERVER _____

REINFORCER USED _____ RELIABILITY _____

LINE _____ COLUMN _____

DIRECTIONS: Note whether a response is present by the appropriate response number. Refer to the manual for the numbers representing each response to the reflex stimulus. CIRCLE "BF" IF THE ARM MOVEMENT BREAKS THE FALL (see definition on the next page).

PROTECTIVE EXTENSION:		RESPONSES:								
FORWARD STIMULI:		TRIALS		1		2		3		
QUICK STIMULUS		RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	R
(displace 30 in 1 sec.)		BF	BF	BF	BF	BF	BF	BF	BF	
SLOW STIMULUS										
(displace 60 in 5 sec.)		BF	BF	BF	BF	BF	BF	BF	BF	
Reliability										
PROTECTIVE EXTENSION:										

PROTECTIVE EXTENSION:		RESPONSES:								
LATERAL STIMULI:		TRIALS		1		2		3		R
QUICK STIMULUS		RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT			
(displace 30 in 1 sec.)		BF	BF	BF	BF	BF	BF			
SLOW STIMULUS										
(displace 60 in 5 sec.)		BF	BF	BF	BF	BF	BF			
Reliability										
DIRECTIONS:		Note whether a response is made								

DIRECTIONS: Note whether a response is present by the appropriate response number. CIRCLE "PE" IF PROTECTIVE EXTENSION IS USED TO RESPOND TO THE STIMULUS IN POSTURAL FIXATION. A RESPONSE OF 4 OR HIGHER IS CONSIDERED A PROTECTIVE RESPONSE FOR THE PURPOSE OF THE DEFINITION USED IN POSTURAL FIXATION.

POSTURAL FIXATION:		RESPONSES:					
FORWARD STIMULUS:		TRIALS		1	2	3	R
Displace 30 in 2-5sec.			PE		PE	PE	
Reliability							
POSTURAL FIXATION:		RESPONSES:					
LATERAL STIMULUS:		TRIALS		1	2	3	R
Displace 30 in 2-5 sec.		RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT
		PE	PE	PE	PE	PE	PE
Reliability							

Figure 12. Data sheet for protective extension and postural fixation.

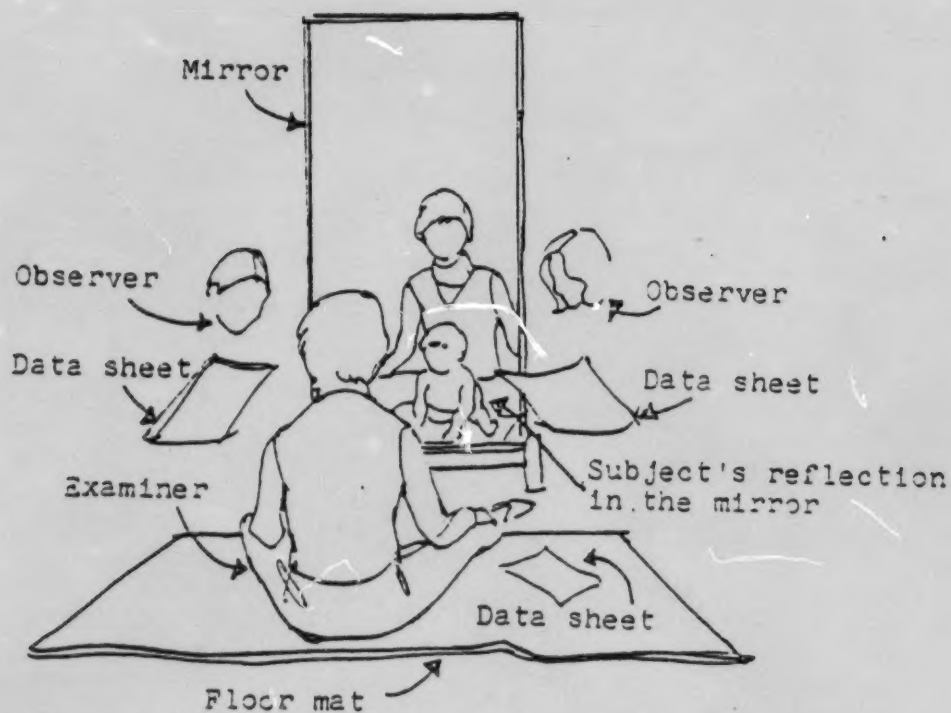


Figure 13. The positioning of the equipment, the subject, the examiner, and the observers for reflex measures.

restrict any movement of the subject's arms or shoulders, but the examiner did prevent the subject from hitting the mat with any other body part (see Figure 14).

Slow stimulus. The examiner displaced the subject's shoulders forward (laterally) 60 degrees within five seconds. The examiner prevented the subject from hitting the mat if an inadequate protective response was elicited.

The following response definitions were used in the measure of protective extension for both stimulus and direction. The range of responses were sequenced to measure emergence and acquisition with #1 representing no development of protective responses and #10 representing a full protective response of the shoulder, arm, and hand (see Figure 15).

Response #1. There was no elbow movement or shoulder movement in the direction to break the fall forward (laterally).

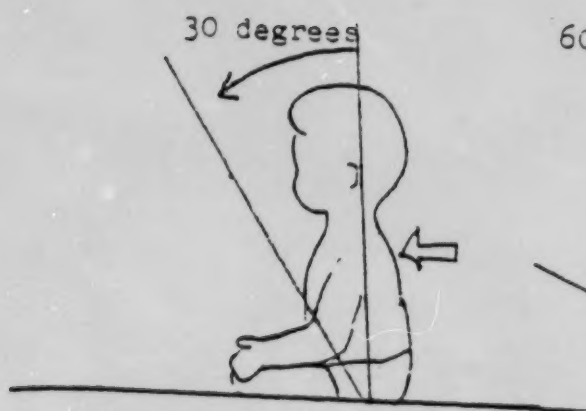
Response #2. The shoulder pulled in the opposite direction from breaking the fall forward (laterally).

Response #3. Only the shoulder moved in the direction to break the fall; there was no elbow extension.

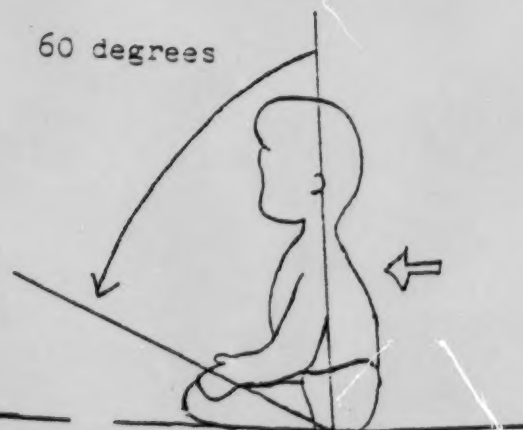
Response #4. The shoulder moved in the direction to break the fall forward (laterally) and the elbow extended with any part of the arm (except the hand) contacting the floor before any other part of the body.

Response #5. The same as response #4 except the hand contacted the floor with a full fist with the palm facing upward.

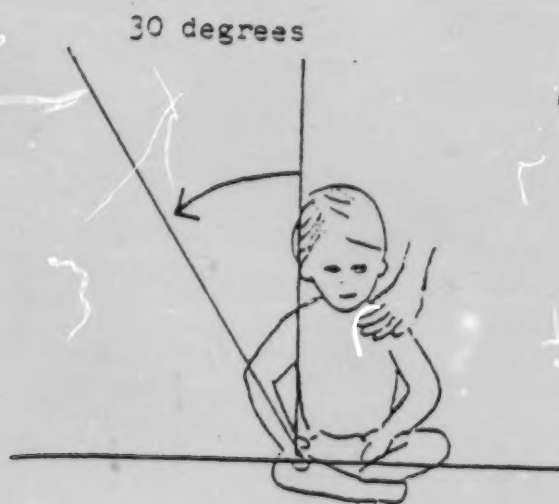
Response #6. The same as response #5 except the full fist contacted the floor with the palm facing downward.



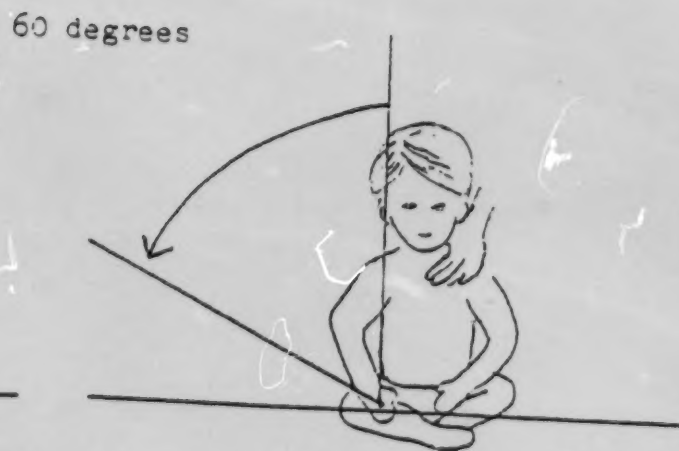
a. Quick stimulus forward



b. Slow stimulus forward



c. Quick stimulus laterally



d. Slow stimulus laterally

Figure 14. Quick and slow stimuli for reflex measures.

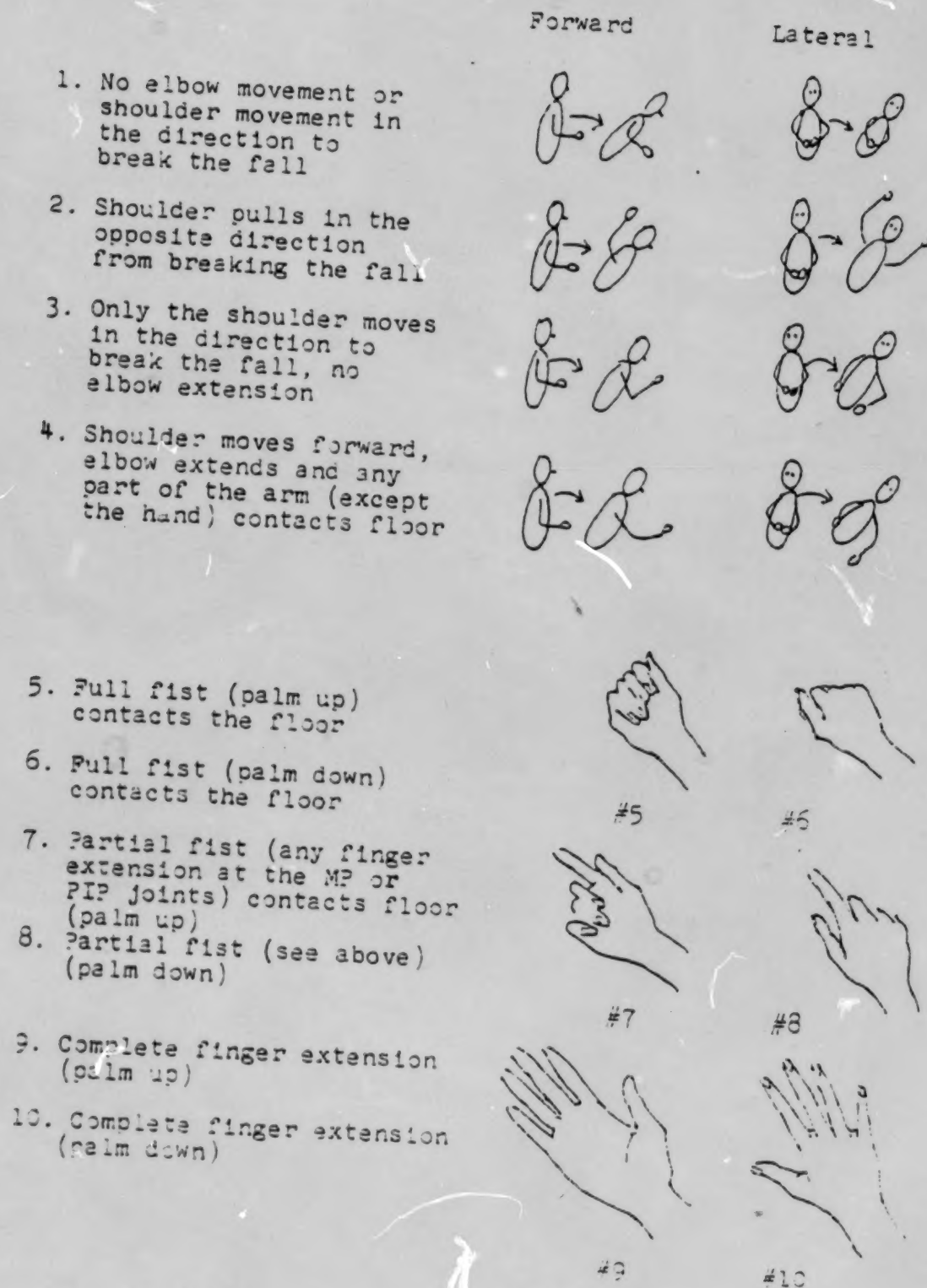


Figure 15. Response definitions accompanying the data sheet for protective extension.

Response #7. The same as response #4 except a partial fist (any finger extension at the metacarpal or phalangeal joints, but the entire hand was not extended) contacted the floor with the palm facing upward.

Response #8. The same as response #7 except the palm was facing downward.

Response #9. The same as response #5 except the hand was fully extended with full finger extension and the palm was facing upward.

Response #10. The same as response #9 except the palm was facing downward.

Breaks the fall (BF). This response indicated that the part of the body breaking the fall forward (laterally) was adequate to support the body weight of the subject with additional forward (lateral) displacement.

Procedures for Measurement

The materials and equipment were arranged and the subject, the examiner, and the observers were positioned as described in the Initial position of the child. The trial was initiated with the examiner providing the stimuli to the subject in the following order:

1. The examiner gave the quick stimulus forward in three successive trials, allowing adequate time between each trial to mark the data sheet for the response elicited.

2. The examiner gave the slow stimulus forward in three successive trials.

3. The quick stimulus to each side was given, three trials to the right and three trials to the left.

4. The slow stimulus to each side was given, three trials to the right and three trials to the left.

Three trials for each stimulus and each direction comprised one session for each subject (i.e., a total of 18 trials).

Marking the Data Sheet

On the data sheet, a column designated the direction of the response for each trial. Rows designated each stimulus used to elicit the response of the subject (see Figure 12).

Following each stimulus, the response of the subject was compared to the response definitions (see Measurement System for this measure). The response number for the definition most nearly matching the subject's response was recorded on the data sheet in the appropriate column and row. The subsequent ability of the subject to "break the fall" was noted for each response number in the same column and row by circling "BF" (see Figure 12).

Computing the Results

The results from the data sheet offered information on two aspects of the protective response: (1) the shoulder, arm and hand movement elicited, and (2) the subsequent ability to break the fall.

The following formula was used to compute the percentage of responses that broke the fall:

$$\frac{\text{\# of occurrences of "BF"}}{\text{\# of occurrences} + \text{\# of non-occurrences}} = \text{Percentage of responses that broke the fall.}$$

The protective ability was considered poor if it was 50% or less; fair if it was 50% to 85%; good if it was 85% or better.

The range of responses was sequenced to measure emergence and acquisition of the full protective response.

Specifications for Taking Reliability Measures

The interobserver reliability was computed as stated in Specifications for Taking Reliability Measures under the section entitled Stability: Asymmetry.

Postural Fixation

This procedure measured the subject's ability to partially or fully realign the head and trunk to an erect sitting posture. In some subjects protective extension of the upper extremities was elicited in response to the stimulus for postural fixation. For this reason, protective extension was included in the response definitions for postural fixation.

Materials and Equipment

Refer to the list of Materials and Equipment under Protective Extension.

Initial Position of the Subject

The positioning of the subject was the same as described under Initial position of child for postural fixation laterally. For postural fixation forward, the subject was positioned so the side of the body faced the observers and the mirror.

Measurement System

Following are the stimulus definitions for postural fixation, anteriorly and laterally:

Postural fixation forward stimulus. The examiner displaced the subject's shoulder forward 30 degrees within two to five seconds (see Figure 16).

Postural fixation laterally stimulus. The examiner displaced the subject's shoulder to the desired side (right or left) 30 degrees within two to five seconds. One of the examiner's hands was used to push the shoulder of the subject to the side while the other hand was positioned to catch the subject if sitting was not maintained or if protective extension was not exhibited.

POSTURAL FIXATION Response Definitions

Responses: Forward and Lateral

All righting should occur within five seconds from initiation of stimulus.

1. No righting - subject continues to fall.
2. Head rights to midline less than upright position.
3. Head rights to upright position.
4. Subject's rights trunk to less than upright position.
5. Subject rights to erect or upright position.



Figure 16. Response definitions accompanying the data sheet for postural fixation.

Following are the response definitions:

Response #1. The subject demonstrated no righting of the head or trunk toward midline and continued to fall to the right or to the left side (see Figure 16).

Response #2. The subject could right the head toward midline, but to less than the upright position (the head had to be perpendicular to the ground to be fully upright) (see Figure 17).

Response #3. The subject could right the head to the upright position (see response #2), but there was no righting of the trunk to midline or to an upright position (see Figure 16).

Response #4. The subject could right the head and trunk toward midline, but to less than the fully upright position (perpendicular to the ground) (see Figure 16).

Response #5. The subject could right the head and the trunk to an erect sitting posture or to an upright position (i.e., the head and the trunk were perpendicular to the ground) (see Figure 16).

Protective extension (PE). The subject used protective extension in the upper extremities in response to the stimulus for postural fixation.

Procedures for Measurement

The materials and equipment were arranged and the subject, the examiner, and the observers were positioned as described in the Conditions for Observation under Protective Extension.

The trial was initiated with the examiner providing the stimuli to the subject in the following order:

1. The examiner gave the stimulus for postural fixation forward in three successive trials.

Responses occurring within five seconds were recorded. Adequate time was allowed after each stimulus to record the subject's response.

2. The stimulus for postural fixation laterally was given three trials to the right and three trials to the left.

A session was comprised of three trials of postural fixation forward and six trials (three in each direction) of postural fixation laterally.

Marking the Data Sheet

Following each stimulus, the response of the subject was compared to the response definitions listed in the Measurement System. The response definition most nearly matching the subject's response was recorded on the data sheet in the appropriate column and row (see Figure 12). If the subject used a protective response of the upper extremity, "PE" was circled in the same space as the response number.

Computing the Results

The range of responses for postural fixation corresponded to the level of the subject's ability to right the head and trunk to the upright position. A #1 response (i.e., no response) was the lowest level of response and a #5 response indicated that the subject demonstrated full head and trunk righting (i.e., the full response for postural fixation).

Specifications for Taking Reliability Measures

Refer to the calculations for interobserver reliability in Specifications for Taking Reliability Measures under Stability: Asymmetry.

MOBILITY INTO THE SITTING POSITION

Come-to-Sit From Sidelying

This tool measured the movement exhibited by the subject when assuming the sitting position from a sidelying position. A series of

probe and prompt procedures were developed to assess the emergence of come-to-sit behaviors in subjects unable to attain the position independently.

Materials and Equipment

The following materials and equipment were used for the assessment of mobility into the sitting position: a floor mat, mirror, stopwatch (optional), and data sheet (see Figure 17).

Initial Position of the Subject

The subject was positioned in sidelying (on either the right or left side) on a floor mat. The arms were relaxed in front of the trunk and the legs were comfortably flexed (approximately 60 degrees of hip flexion and 45 degrees of knee flexion) (see Figure 18).

Position of the Materials and the Equipment

The floor mat and the mirror were positioned as specified for the measure of Protective Extension.

Position of the Observers

The observers were positioned next to the floor mat, facing the examiner and the subject. The examiner was positioned in sitting directly behind the subject, facing the observers (see Figure 18).

Measurement System

A number of terms were used in this assessment to describe: (1) the starting position of the subject, (2) the probe and prompt procedures, (3) the come-to-sit behaviors of the subject in response to the probe and prompt procedures, and (4) the response of the subject when the physical support was released. Note below the definitions for this tool:

Starting position. This was defined as the side (right or left) on which the subject was lying when the trial began.

COME TO SIT FROM SIDELYING

SUBJECT _____ EXAMINER _____
 DATE _____ PHASE _____ OBSERVER _____
 REINFORCER _____ RELIABILITY _____
 LINE _____ COLUMN _____

I. STARTING POSITION		RIGHT SIDE	LEFT SIDE			
				(Note +, -, NA)		
ASSISTS	RESPONSES	Trial		Comments	R	
		1	2			
PROBE 1	a. Independent (I)					
	b. No response (NR)					
PROBE 2	c. Touch shoulder (TS)-1					
	d. Touch Shoulder (TS)-NR					
PROMPT 1 0-30°	a. I					
	b. NR					
	c. Head Rights					
	d. Shoulder moves out					
PROMPT 2 30°-60°	a. I					
	b. NR					
	c. Elbow moves out to prop					
	d. Hand down-fisted					
	e. Hand down-palm (any part)					
PROMPT 3 60°-90°	a. I-lifts up hand					
	b. I-props on hand 2 sec.					
	c. I-props on hand 2 sec.					
	d. Hand down-fisted					
	e. Hand down palm (any part)					
	f. Hand down-all fingers extended					
RELEASE at 90°	g. NR					
	a. Maintains sitting					
	b. Props 2 sec.					
	c. Props 2 sec.					
	d. Subject falls forward					
	e. Subject falls sideward					
	f. Subject falls backward					
RELIABILITY						

NO PROMPTS - Record the behaviors as follows:
 In initial 30° of behavior - note responses in Prompt 1 category.
 In 30°-60° of behavior - note responses in Prompt 2 category.
 In 60°-90° of behavior - note the responses in Prompt 3 category and RELEASE category.

Figure 17. Data sheet for come to sit.

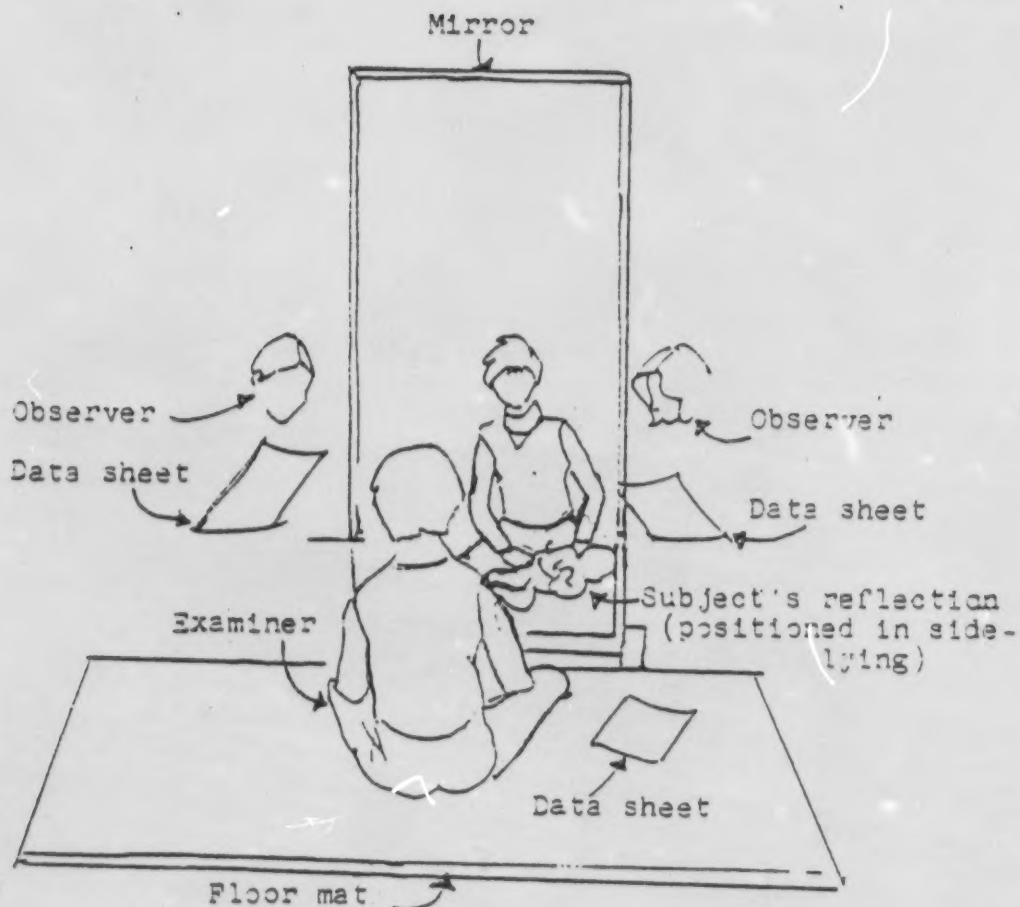


Figure 18. Positioning of the equipment, the subject, the examiner, and the observers for the come to sit measure.

Probe 1. This probe referred to the examiner's initial attempt to elicit movement of the subject into sitting. The examiner offered verbal encouragement and/or desired food or toys as reinforcers to the subject. This probe lasted 15-30 seconds.

Probe 2. Probe 2 always followed Probe 1 if no response was elicited. The examiner touched the subject's down shoulder (the shoulder on the floor) and said, "Sit up, (child's name)." The same reinforcement offered in Probe 1 was offered in Probe 2. This probe lasted 15 to 30 seconds.

Prompt 1. The first prompt consisted of the examiner slowly lifting the down shoulder (the shoulder on the floor) up to 30 degrees in five seconds (see Figure 19).

Prompt 2. Prompt 2 followed Prompt 1 and consisted of slowly moving the subject's down shoulder from 30 degrees to 60 degrees in five seconds.

Prompt 3. Prompt 3 followed Prompt 2 and consisted of slowly moving the subject's down shoulder from 60 degrees to 90 degrees in five seconds (see Figure 19).

Release. Release immediately followed Prompt 3 and required that the examiner's hand be removed from the subject's down shoulder. The examiner's hand was repositioned to catch the subject, if he or she fell from the sitting position. The release lasted five seconds from the moment that the hand support was dropped from the shoulder.

The response definitions were coded to simplify the collection of data. The responses varied with the probes and the prompts offered by the examiner. The definitions for responses corresponding with the probes were:



a. Initial position-
side-lying



b. Prompt 1-
assist from initial
position to 30 degrees



c. Prompt 2-
assist from 30 degrees
to 60 degrees



d. Prompt 3-
assist from 60 degrees
to 90 degrees
(upright posture)

Figure 19. Definitions of physical prompts used for come to sit measure.

Independent. The term indicated that the subject assumed sitting independently during Probe 1.

No response. This term indicated that the subject did not assume sitting independently during Probe 1.

TS-1. "Touch shoulder-independently," indicated that the subject assumed sitting independently during Probe 2.

TS-NR. "Touch shoulder-no response," indicated that the subject did not assume sitting independently during Probe 2.

Following are the response definitions for the prompt procedure:

For Prompt 1:

I. "Independent," indicated that the subject assumed sitting independently during Prompt 1 (see Figure 20).

NR. "No response," indicated that there was no movement of the head to the upright position and there was no movement of either arm into a propping position (see Figure 20).

Head rights. This term indicated that the head started to move into an upright position (see Figure 20).

Shoulder moves out. Any shoulder movement outward of the down shoulder that was greater than 30 degrees abduction (moving the arm directly out to the side) (see Figure 20).

The following definitions were used under Prompt 2:

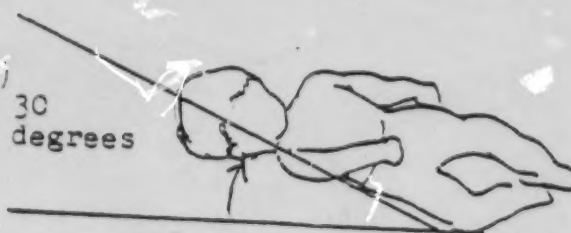
I. "Independent," indicated that the subject assumed sitting independently during the second prompt, lifting the subject's shoulder from 30 degrees to 60 degrees (see Figure 20).

NR. "No response," indicated that the subject did not move his or her down arm into a propping or pushing position during the second prompt (see Figure 20).

a. I (Independent)



b. NR (no response)



c. Head rights



d. Shoulder moves out



Figure 20. Responses to prompt 1 for the come to sit procedure.

Elbow moves out to prop. The subject moved the down arm in order to prop or push up and the elbow angle was greater than 90 degrees (see Figure 21).

Hand down/fisted. The subject placed the down hand on the mat with any of the fingers flexed, making a full or partial fist (see Figure 21).

Hand down/palm, (any part). The subject placed the down hand on the mat with any part of the palm touching the mat, regardless of whether or not the hand was fisted (see Figure 21).

The following definitions accompanied Prompt 3, lifting the subject's down shoulder from 60 to 90 degrees:

I-lifts up hand. "Independently lifts up hand," indicates that the subject completed coming to the sitting position and lifted up the down hand during Prompt 3.

I-props on hand 2 sec. "Independently props on hands less than two seconds," indicated that the subject completed the movement into the sitting position during Prompt 3 and propped on the down hand for less than two seconds.

I-props on hand 2 sec. "Independently props on the hand equal to or more than two seconds," indicated that the subject completed coming-to-sitting independently during Prompt 3 and propped on the down hand two seconds or more.

Hand down/fisted. Refer to this definition under Prompt 2.

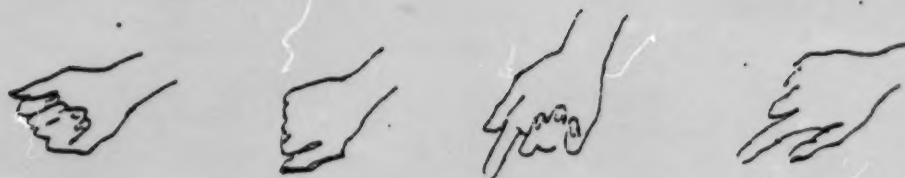
Hand down/palm (any part). Refer to this definition under Prompt 2.

Hand down/all fingers extended. The down hand was placed on the mat or maintained on the mat for at least one second with all the fingers and the thumb extended. (Extension of the metacarpals and the phalanges was evident for the entire hand.)

a. Elbow moves out



b. Hand down/fisted



c. Hand down/palm



d. Hand down/fingers extended



Figure 21. Responses to prompt 2 and prompt 3 for the come to sit procedure.

NR. "No response," indicated that there was no further response from Prompt 2, or no additional behavior observed during Prompt 3.

The final list of response definitions corresponds with release at 90 degrees:

Maintains sitting. The subject did not fall in any direction when the shoulder support was released. The amount of time that sitting was maintained was at least five seconds.

Props 2 sec. This indicated that the subject propped on the down arm for less than two seconds. Refer to Prompt 3, I-props on hand 2 secs.

Props 2 sec. This signified "props more than or equal to two seconds." Refer to Prompt 3, I-props 2 sec.

Subject falls sideways. The subject fell to either side within five seconds of the release of the shoulder support, so that the trunk landed behind the initial position of either knee.

Subject falls backward. The subject fell backward within five seconds of the release of shoulder support.

Procedures for Measurement

1. The subject, the examiner and the observers were positioned as described under Initial position of subject. The examiner and the observers noted the "starting position" on the data sheet.
2. The subject was passively moved through the prompt procedure, lifting the down shoulder through the 90-degree arc in a 15-second time period. During this passive movement the examiner stated, "Come to sit, (child's name)."
3. After passively moving the child through the come-to-sit procedure twice, the examiner probed the subject's ability to move into sitting.

4. For Probe 1, the examiner offered the subject a desired object or food and the examiner verbally encouraged the subject to come to sit by stating, "Sit up, (child's name)." If the child responded by assuming a sitting position, the data sheet was marked under Trial 1, noting all the behaviors that the child exhibited. Adequate time was allowed to record this information on the data sheet. If the subject moved into the sitting position in the initial 30 seconds, this completed one trial. Two trials were conducted each session.

5. If the subject did not respond to Probe 1, then Probe 2 was initiated to encourage the subject to come to sit. Probe 2 was the same as Probe 1, except the examiner touched the subject's shoulder and repeated the request. The data sheet was marked, recording all of the responses exhibited, if the subject assumed sitting during this probe.

6. If the subject did not assume sitting with either of the probe procedures, the prompt procedure was begun.

7. For Prompt 1, the examiner slowly lifted the subject's down shoulder through an arc from approximately 0 to 30 degrees, counting one through five seconds. The examiner stabilized the subject's hips as needed. If the subject continued coming-to-sit independently, the examiner continued counting for a total of 20 seconds for the completion of the prompt procedure. The trial ended and the examiner and the observers marked the data sheet. If the subject did not come-to-sit independently, the examiner immediately continued with Prompt 2.

8. In Prompt 2, the examiner slowly lifted the subject's down shoulder from 30 to 60 degrees in five seconds. If the subject assumed sitting independently during this prompt, the data sheet was marked recording all of the behaviors exhibited by the subject. If the subject

did not assume sitting independently from Prompt 2, the examiner immediately began Prompt 3.

9. In Prompt 3, the examiner lifted the subject's down shoulder from 60 to 90 degrees in five seconds. If the subject did not assume sitting independently during Prompt 3, the examiner completed the prompt procedure with the release at 90 degrees (the subject was in sitting at 90 degrees). Otherwise, the data sheet was marked, indicating all behaviors exhibited.

10. The support on the subject's shoulder was released and the subject's response was observed for five seconds. Observations for the entire trial were recorded on the data sheet at the end of this five seconds if the subject did not assume sitting independently prior to the release.

Two trials were completed each session. After each trial, responses were recorded on the data sheet corresponding to the probe and prompt procedures utilized.

Marking the Data Sheet

1. The starting position, sidelying on the "right side" or the "left side" was checked.

2. A plus sign (+) was used to designate the presence of a behavior and a minus sign (-) was used to designate the absence of a behavior. Each behavior was marked as it corresponded with the angle of the trunk, regardless of the number of prompts provided.

3. It was assumed that all prompts were given to the subject unless a notation in the comment column indicating "no prompt" was written.

Computing the Data

The amount of assistance for each subject was indicated by the number of prompts carried out by the examiner. A subject requiring all three prompts was less independent in mobility into sitting than a subject requiring two or less prompts.

The percentage of come-to-sit behavior was computed by the following equation:

$$\frac{\begin{array}{l} \# \text{ of occurrences of come-to-sit behavior} \\ \# \text{ of occurrences of come-to-sit behavior} + \\ \# \text{ of occurrences of no response and} \\ \text{falling} \end{array}}{\quad} = \begin{array}{l} \text{Percentage of} \\ \text{come-to-sit} \\ \text{behavior of all} \\ \text{behaviors} \\ \text{exhibited.} \end{array}$$

The percentage of falling or no response was computed using the same equation, substituting the "number of occurrences of falling and no response" for "number of occurrences of come-to-sit behavior" in the numerator of the equation.

Specifications for Taking Reliability Measures

Refer to the Specifications for Taking Reliability Measures under Stability: Asymmetry.

Subjects

The study included a total of four subjects, with three subjects chosen from the Children's Rehabilitation Unit at the University of Kansas Medical Center. The three handicapped subjects were selected on the basis of their motoric ability. They all were classified as developmentally delayed and all exhibited head erect for at least five seconds in the sitting position, but were unable to come to sit independently. The nonhandicapped subject was selected from the infant day care unit at the University of Kansas Medical Center on the basis of age, six months, which corresponded with the emergence of sitting behavior in normal infants.

Subject 1

P.H. was a two-year, seven-month old male with a diagnosis of cerebral palsy with spastic quadriplegia. He was able to maintain his head in an upright position for 30 seconds when placed in a supported sitting position. Once positioned in sitting, he sat propping with both upper extremities for less than 10 seconds.

Subject 2

J.B. was a five-year, three-month old male with a diagnosis of developmental delay. He was able to maintain a sitting position independently indefinitely; however, he was unable to assume sitting independently. J.B. demonstrated good head control in all postures.

Subject 3

M.S. was a six-year, one-month old female with a diagnosis of cerebral palsy with spastic quadriplegia. She was able to roll in both directions and prone drag (i.e., pull herself forward using her arms when she was positioned on her stomach) a short distance on command. She maintained sitting using her upper extremities for support for less than one minute. She was unable to assume sitting independently.

Subject 4

J.H. was a six-month old male with no evidence of physical disability. He maintained his head erect indefinitely in all postures and when placed in supported sitting he maintained the posture for more than one minute.

Results

Measures of Interobserver Reliability

The interobserver reliability data are presented in Tables 1 to 10. Tables 1 to 6 present interobserver reliability data for descriptors

across trials and across subjects for stability: asymmetry, stability: cumulative duration, protective extension forward, protective extension laterally, postural fixation, and come-to-sit. Tables 7 to 10 present interobserver reliability data for descriptors of asymmetry: stability across trials and across time checks for each subject.

Subject 1 (P.H.). Interobserver reliability for stability: asymmetry ranged from 79% to 100% across behavior descriptors and from 76% to 94% across trials with a mean of 87% (see Table 1). Interobserver reliability for stability: cumulative duration was 100% across all behavior descriptors and all trials (see Table 2).

In Table 7, reliability scores across trials and time checks for stability: asymmetry ranged from 54% to 100% for time checks, with a mean of 79% for the ear position, 82% for the shoulder position, and 100% for the sitting position.

The interobserver reliability for protective extension forward ranged from 0% to 100% across behavior descriptors for both arms (see Table 3). The row mean reliability for the right arm was 97% for the quick stimulus and 90% for the slow stimulus. The row mean reliability for the left arm was 94% for the quick stimulus and 90% for the slow stimulus. The interobserver reliability for protective extension laterally ranged from 0% to 100% for the right arm and from 25% to 100% for the left arm across all behavior descriptors (see Table 4). The row mean reliability for the left arm was 98% for the quick stimulus and 97% for the slow stimulus.

The reliability across behavior descriptors for postural fixation ranged from 90% to 100% for the response numbers and from 94% to 98% for the stimuli presented (see Table 5). The row mean reliability was 96% based on occurrence data.

TABLE 1

Percent Reliability Scores for Descriptors Across Trials
and Across Subjects for Stability: Asymmetry

Subject	Trials	Descriptors		Sitting Position	Row Mean Reliability
		Position Ear	Viewed Shoulder		
1	1	86	82	100	89
	2	82	86	100	89
	3	91	91	100	94
	4	54	73	100	76
	5	82	82	100	88
Column mean reliability (1)		79	83	100	87
2	1	100	59	100	86
	2	59	73	100	77
	3	82	68	100	83
	4	91	27	100	73
	5	91	100	100	97
	6	82	91	100	91
Column mean reliability (2)		84	70	100	85
3	1	91	91	100	94
	2	73	73	59	68
	3	45	54	100	67
	4	91	82	100	91
	5	95	86	100	94
Column mean reliability (3)		80	77	92	83
4	1	83	100	100	94
	2	95	95	100	97
	3	100	91	100	97
	4	91	82	100	91
Column mean reliability (4)		92	92	100	95
Column mean reliability overall		83	76	93	

Grand Mean
Reliability 87%

TABLE 2

Percent Reliability Scores for Descriptors Across Trials and
Across Subjects for Stability: Cumulative Duration

Subjects	Trials	Initial	Descriptors Position of the Subject Trisection			Duration		Side of the Subject viewed		Row Mean Reliability
			I	II	III	Total	Cumulative	Right	Left	
1	1	100				100				100
	2	100		100		100	100		100	
2	1	100	100			100	100		100	100
	2	100	100			100	100		100	100
	3	100	100			100	100		100	100
	4	100	100			100	100		100	100
3	1	100		100		100	100		100	100
	2	100		100		100	100		100	100
4	1	100		100		100	100		100	100
	2	100	100			100	100		100	100
	3	100	100			100	100		100	100
Column Mean Reliability			100	100		100	100		100	

Grand Mean
Reliability 100

TABLE 3

Mean Percent Reliability Scores for Each Descriptor and Stimulus
Across Trials and Across Subject for Protective Extension Forward

Subjects	Total Number of Trials	Right Arm Descriptors - Responses to Quick Stimulus - Responses to Slow Stimulus - (number of occurrences)											Row Mean Rel.
		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	3F	
1	15	100 (14)		0 (1)								100 (15)	97
		100 (3)		100 (3)	0 (1)		75 (3)					100 (15)	90
2	9	100 (1)						100 (3)	80 (5)			100 (5)	93
		100 (2)						100 (4)	87 (3)			100 (5)	93
3	12	100 (5)	100 (1)	62 (5)			0 (2)					100 (5)	83
		87 (4)		100 (1)			50 (3)	50 (1)	100 (2)		50 (2)	100 (5)	76
4	9				50 (1)		50 (1)		100 (5)		100 (1)	100 (2)	92
							0 (1)		100 (3)			100 (9)	94
Column Mean Reliability		100 (20) 94 (9)	100 (1)	52 (6) 100 (4)	50 (1) 0 (1)	0 (0)	33 (3) 62 (9)	100 (3) 90 (5)	90 (10) 92 (12)	0 (0)	100 (1) 50 (2)	100 (14) 100 (24)	91 83

Subjects	Left Arm Descriptors												Row Mean Rel.
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	3F		
1	15	91 (10)	100 (3)	50 (2)								100 (15)	94
		100 (6)	100 (3)	100 (1)		0 (1)	50 (4)					100 (15)	90
2	9							100 (3)	100 (4)	0 (2)		100 (5)	86
		100 (1)						100 (3)	100 (4)	0 (1)		100 (5)	93
3	12	100 (5)		50 (6)			0 (1)					100 (5)	76
		87 (4)		100 (1)			50 (3)	50 (1)	87 (3)			100 (5)	79
4	9								100 (3)		75 (4)	100 (2)	87
									100 (3)		0 (1)	100 (3)	95
Column Mean Reliability		93 (15) 95 (11)	100 (7) 100 (3)	50 (8) 100 (2)	0 (0)	0 (1)	25 (7) 50 (4)	100 (4) 37 (15)	100 (3) 92 (10)	50 (2) 0 (2)	100 (6) 100 (2)	100 (29) 100 (20)	90 89

Grand Mean
Reliability

84%

TABLE 4

Mean Percent Reliability Scores for Each Descriptor and Stimulus
Across Trials and Across Subjects for Productive Extension Laterally

Subjects	Total Number of Trials	Right Arm Descriptors - Responses to Quick Stimulus - Responses to Slow Stimulus (number of occurrences)										Row Mean Rel.	
		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10		BF
1	15	100 (14) (9)	0 (1)	50 (1) 100 (3)			50 (2)				100 (15) 100 (95)	98 (98) 97 (97)	
2	7	100 (2) 100 (2)			100 (1)				100 (2) 100 (4)	100 (3)	100 (7) 100 (7)	100 (100) (100) (100)	
3	12	95 (11) 100 (8)	50 (1) 25 (2)		50 (2)						100 (5) 100 (5)	97 (97) 85 (85)	
4	9								94 (3) 100 (7)	100 (1) 100 (2)	100 (9) 100 (9)	97 (97) (97) (97)	
Column Mean Reliability		98 (27) 100 (19)	50 (1) 17 (3)	50 (1) 80 (5)	50 (0) 100 (1)	50 (0) 50 (2)	50 (2) (2)	50 (0) (0)	95 (10) 100 (11)	100 (0) 100 (2)	100 (4) 100 (30)	97 (97) 97 (97)	
Subjects		Left Arm Descriptors											
		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10		BF
1	15	90 (15) 100 (10)	50 (2)	100 (2)			100 (1)				100 (15) 100 (15)	98 (98) 97 (97)	
2	7			100 (1)					100 (3)	100 (3)	100 (7) 100 (7)	100 (100) (100) (100)	
3	12	80 (10) 100 (12)	80 (2)						100 (1) 100 (4)		100 (5) 100 (5)	97 (97) 97 (97)	
4	9								94 (3) 100 (7)	100 (1) 100 (2)	100 (9) 100 (9)	97 (97) (97) (97)	
Column Mean Reliability		90 (25) 100 (22)	50 (1) 30 (2)	100 (1) 100 (1)	50 (0) (0)	50 (0) (2)	50 (0) (2)	50 (0) (0)	95 (10) 91 (11)	100 (0) 100 (2)	100 (4) 100 (30)	97 (97) 97 (97)	

Grand Mean
Reliability 97

TABLE 5

Mean Percent Reliability Scores for Each Descriptor
Across Trials and Across Subjects for Postural Fixation

Subjects	Trials	Stimulus	Descriptors Response numbers (# of occurrences)						Row Mean Rel.
			1	2	3	4	5	95	
1	9	Forward	83 (6)	92 (6)				100 (12)	94 (24)
		Lateral-R	94 (9)	83 (3)				100 (12)	95 (24)
		Lateral-L	95 (11)	100 (1)				100 (12)	98 (24)
		Column Mean Reliability for 1	93 (26)	90 (10)				100 (36)	96 (72)
2	4	Forward					100 (7)	83 (6)	92 (13)
		Lateral-R					100 (7)	100 (5)	100 (12)
		Lateral-L					100 (7)	100 (6)	100 (13)
		Column Mean Reliability for 2					100 (21)	94 (18)	97 (39)
3	12	Forward	100 (5)		100 (1)	100 (3)	67 (3)	100 (5)	94 (17)
		Lateral-R	100 (6)			100 (3)	83 (3)	100 (3)	97 (17)
		Lateral-L	100 (9)		50 (1)	100 (2)		100 (3)	97 (17)
		Column Mean Reliability for 3	100 (25)		75 (2)	100 (3)	75 (6)	100 (15)	96 (51)
4	9	Forward					100 (9)	100 (9)	100 (18)
		Lateral-R		0 (1)			100 (3)	83 (2)	86 (12)
		Lateral-L				100 (1)	100 (3)	94 (2)	97 (18)
		Column Mean Reliability for 4		0 (1)		100 (1)	100 (3)	93 (11)	94 (27)
Column Mean Reliability (overall)			96 (51)	75 (12)	75 (2)	100 (14)	87 (53)	97 (36)	96 (116)

Grand Mean
Reliability 96%

TABLE 6

Mean Percent Reliability Scores for Descriptors and Stimulus
Across Trials and Across Subjects for Come-to-Sit

Subjects						
Percent Reliability Scores (number of occurrences)						
Descriptors		#1	#2	#3	#4	Row
Stimulus	Response	total	(4 trials)	(8 trials)	(4 trials)	Mean Rel.
Probe 1	Independent				100 (4)	100 (4)
	No response	100 (8)	100 (4)	100 (8)		100 (80)
Probe 2	Independent				75 (2)	75 (2)
	No response	100 (3)	100 (4)	94 (3)		97 (20)
Prompt 1	Independent				100 (4)	100 (4)
	No response			80 (5)		80 (5)
	Head rights	93 (7)	100 (4)	82 (3)	100 (4)	93 (23)
	Shoulder	50 (6)	50 (4)	100 (3)	37 (4)	58 (17)
	Moves Out					
			100 (1)		100 (4)	100 (5)
Prompt 2	Independent					
	No response	33 (3)		100 (2)		60 (5)
	Elbow	100 (4)	100 (3)	33 (5)	100 (3)	94 (16)
	Moves out					
	Hand down/ fisted	90 (5)	50 (2)	90 (5)	0 (1)	78 (13)
	Hand down/ palm	50 (4)	33 (3)		100 (4)	77 (11)
Prompt 3	Independent		33 (3)	75 (2)	100 (3)	37 (8)
	Lifts hand					
	Independent		33 (3)	50 (1)	75 (3)	75 (7)
	pross 2 s.					
	Independent	0 (1)	100 (1)			50 (2)
	pross 2 s.					
	Hand down/ fisted	100 (2)	50 (2)	50 (2)	100 (1)	71 (7)
	Hand down/ palm	50 (2)	100 (1)	50 (1)	36 (3)	64 (7)
	Hand down/ extended				25 (2)	25 (2)
	No response	58 (6)		70 (5)		64 (11)
			100 (4)		100 (4)	100 (8)
		100 (4)	37 (2)	33 (2)	30 (2)	75 (10)
Release	Hands sit.					
	Probe 2 s.					
	Probe 2 s.					
	Probe 2 s.					
	Probe 2 s.					
Fall. Forward						
Fall. backward						
Column Mean Reliability		52 (44)	54 (21)	54 (21)	54 (21)	54 (21)

TABLE 7
Percent Reliability Scores for Descriptors Across Trials and
Across Time Checks for Subject 1
for Stability: Asymmetry

Descriptor Trials (position observed)	(Elapsed time (in seconds))											Row Mean Rel.
	0:00	0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00	2:15	2:30	
1 Ear/	100	100	100	100	100	100	50	100	50	50	100	36
Shoulder/	100	100	100	50	100	100	50	50	100	50	100	32
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
2 Ear/	100	50	50	50	100	100	50	100	100	100	100	32
Shoulder/	100	100	50	100	100	100	50	50	100	100	100	36
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
3 Ear/	100	50	100	100	100	100	100	50	100	100	100	91
Shoulder/	100	50	100	100	100	100	100	50	100	100	100	91
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
4 Ear /	100	100	100	100	100	100	0	0	100	0	0	54
Shoulder/	100	100	100	100	0	0	100	100	0	100	100	73
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
5 Ear/	100	100	100	100	100	100	0	100	100	0	100	32
Shoulder/	100	100	100	100	100	100	100	100	100	0	0	32
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
Column Mean Reliability	100	90	93	93	87	82	72	80	80	73	47	
Ear/												73
Shoulder/												33
Sitting												100

Grand Mean
Reliability 47%

The reliability data for come-to-sit ranged from 0% to 100% across behavior descriptors with a mean of 92% across descriptors and trials for Subject 1 (see Table 6).

Subject 2 (J.B.). Interobserver reliability for stability: asymmetry ranged from 70% to 100% across behavior descriptors and 73% to 97% across trials with a mean of 85% (see Table 1). Interobserver reliability for stability: cumulative duration was 100% across all behavior descriptors and all trials (see Table 2).

In Table 8, reliability scores across trials and time checks for stability: asymmetry ranged from 72% to 100% for time checks, with a mean of 85% for the ear position, 70% for the shoulder position, and 100% for the sitting position.

The interobserver reliability for protective extension forward ranged from 0% to 100% across behavior descriptors for both arms (see Table 3). The row mean reliability for the right arm was 93% for both the quick and the slow stimuli. The row mean reliability for the left arm was 86% for the quick stimulus and 93% for the slow stimulus. The reliability for protective extension laterally was 100% for the right arm and ranged from 0% to 100% for the left arm for all behavior descriptors (see Table 4). The row mean reliability for the right arm was 100% for both the quick and the slow stimuli and for the left arm was 79% for the quick stimulus and 93% for the slow stimulus. The reliability across behavior descriptors for postural fixation ranged from 94% to 100% across the response numbers and from 92% to 100% for the stimuli presented (see Table 5). The row mean reliability was 97% across descriptors and trials.

TABLE 8
Percent Reliability Scores for Descriptors Across Trials and
Across Time Checks for Subject 1
for Stability: Asymmetry

Descriptor Trials (position observed)	(Elapsed time (in seconds))											Row Mean Rel.
	0:00	0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00	2:15	2:30	
1 Ear/	100	100	100	100	100	100	100	100	100	100	100	100
Shoulder/	100	100	0	0	0	100	100	100	50	50	50	59
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
2 Ear/	100	50	50	50	50	50	50	50	100	50	50	59
Shoulder/	100	100	100	100	100	50	50	50	0	50	100	73
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
3 Ear/	100	100	100	100	100	100	50	0	50	100	100	32
Shoulder/	100	0	100	50	50	50	100	0	100	100	100	68
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
4 Ear/	100	100	100	100	100	100	0	100	100	100	100	91
Shoulder/	100	100	0	0	100	0	0	0	0	0	0	27
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
5 Ear/	100	100	100	100	100	0	100	100	100	100	100	91
Shoulder/	100	100	100	100	100	100	100	100	100	100	100	100
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
6 Ear/	100	100	0	100	100	100	100	0	100	100	100	32
Shoulder/	100	100	0	100	100	100	100	100	100	100	100	91
Sitting	100	100	100	100	100	100	100	100	100	100	100	100
Column Mean Reliability	100	91	73	93	39	30	30	72	33	26	33	
Ear/												
Shoulder/												
Sitting												

Grand Mean
Reliability 44

The reliability data for come-to-sit ranged from 50% to 100% across all behavior descriptors with a mean of 84% across descriptors and trials for Subject 2 (see Table 6).

Subject 3 (M.S.). Interobserver reliability for stability: asymmetry ranged from 77% to 92% across behavior descriptors and from 67% to 94% across trials with a mean reliability of 83% (see Table 1). Interobserver reliability for stability: cumulative duration was 100% across all behavior descriptors and all trials (see Table 2).

In Table 9 reliability scores across trials and time checks for stability: asymmetry ranged from 45% to 100% for time checks, with a mean of 79% for the ear position, 77% for the shoulder position, and 92% for the sitting position.

The interobserver reliability for protective extension forward ranged from 0% to 100% for both arms (see Table 3). The row mean reliability for the right arm was 83% for the quick stimulus and 76% for the slow stimulus. The row mean reliability for the left arm was 76% for the quick stimulus and 79% for the slow stimulus. The reliability for protective extension laterally ranged from 25% to 100% for the right arm and from 50% to 100% for the left arm (see Table 4). The row mean reliability for the right arm was 91% for the quick stimulus and 85% for the slow stimulus. The row mean reliability for the left arm was 82% for the quick stimulus and 100% for the slow stimulus. The reliability scores across behavior descriptors for postural fixation ranged from 75% to 100% across the response numbers and from 94% to 97% across the stimuli presented (see Table 5). The row mean reliability was 96% across behavior descriptors and across trials.

TABLE 9

Percent Reliability Scores for Descriptors Across Trials
for Subject 3 in Stability: Asymmetry

Asymmetry														
Trial	Descriptor Position observed)	Elapsed time in Seconds												Row Mean Rel.
		0:00	0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00	2:15	2:30		
1	Ear	100	100	100	100	100	100	100	100	100	100	0	91	
	Shoulder	100	100	100	100	100	50	50	100	100	100	100	91	
	Sitting	100	100	100	100	100	100	100	100	100	100	100	100	
2	Ear	100	100	100	100	100	50	50	50	50	50	50	73	
	Shoulder	100	100	100	100	100	50	50	50	50	50	50	73	
	Sitting	100	100	100	100	100	0	0	0	50	50	50	59	
3	Ear	100	100	0	0	0	50	0	50	100	100	0	45	
	Shoulder	100	100	100	0	50	0	0	50	100	50	50	54	
	Sitting	100	100	100	100	100	100	100	100	100	100	100	100	
4	Ear	100	100	100	100	100	100	0	100	100	100	100	91	
	Shoulder	100	100	0	50	100	50	100	100	100	100	100	82	
	Sitting	100	100	100	100	100	100	100	100	100	100	100	100	
5	Ear	100	100	100	100	100	100	100	100	100	100	50	91	
	Shoulder	100	0	100	100	100	100	100	100	100	100	50	86	
	Sitting	100	100	100	100	100	100	100	100	100	100	100	100	
Column Mean Reliability		100	93	87	83	90	70	63	80	90	87	80		
Ear														79
Shoulder														77
Sitting														92

Grand Mean
Reliability

82

The reliability data for come-to-sit ranged from 50% to 100% across behavior descriptors and trials for Subject 3 (see Table 6).

Subject 4 (J.H.). Interobserver reliability for stability: asymmetry ranged from 92% to 100% across behavior descriptors and from 71% to 97% across trials with a mean of 95% (see Table 1). Interobserver reliability for stability: cumulative duration was 100% across all behavior descriptors and all trials (see Table 2).

In Table 10, reliability scores across trials and time checks for stability: asymmetry ranged from 82% to 100% for time checks, with a mean of 92% for the ear position, 92% for the shoulder position, and 100% for the sitting position.

The interobserver reliability for protective extension forward ranged from 0% to 100% for both arms (see Table 3). The row mean reliability for the right arm was 92% for the quick stimulus and 94% for the slow stimulus. The row mean reliability for the left arm was 89% for the quick stimulus and 94% for the slow stimulus. The reliability for protective extension laterally ranged from 94% to 100% for the right arm and from 0% to 100% for the left arm (see Table 4). The row mean reliability for the right arm was 97% for the quick stimulus and 100% for the slow stimulus. The row mean reliability for the left arm was 83% for both the quick and slow stimulus. The reliability across behavior descriptors for postural fixation ranged from 0% to 100% across response numbers and from 86% to 100% across the stimuli presented (see Table 5). The row mean reliability was 94% across descriptors and across trials.

The reliability data for come-to-sit ranged from 0% to 100% across behavior descriptors with a mean of 90% across descriptors and trials for Subject 4.

TABLE 10

Percent Reliability Scores for Descriptors Across Trials
for Subject 4 in Scalability: Asymmetry

Trial	Descriptor (Position observed)	Elapsed time in Seconds												Row Mean Rel.
		0:00	0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00	2:15	2:30		
1	Ear	100	100	100	100	100	100	100	100	50	100	100	91	
	Shoulder	100	100	100	100	100	100	100	100	100	100	100		
	Sitting	100	100	100	100	100	100	100	100	100	100	100		
	Column Mean Reliability on Trial 1	100	100	100	100	100	100	100	100	83	100	100		
2	Ear	100	100	100	100	50	100	100	100	100	100	100	95	
	Shoulder	100	100	100	100	50	100	100	100	100	100	100		
	Sitting	100	100	100	100	100	100	100	100	100	100	100		
	Column Mean Reliability on Trial 2	100	100	100	100	67	100	100	100	100	100	100		
3	Ear	100	100	100	100	100	100	100	100	100	100	100	91	
	Shoulder	100	100	100	100	100	100	0	100	100	100	100		
	Sitting	100	100	100	100	100	100	100	100	100	100	100		
	Column Mean Reliability on Trial 3	100	100	100	100	100	100	67	100	100	100	100		
4	Ear	100	100	0	100	100	100	100	100	100	100	100	91	
	Shoulder	100	100	0	100	100	100	0	100	100	100	100		
	Sitting	100	100	100	100	100	100	100	100	100	100	100		
	Column Mean Reliability on Trial 4	100	100	33	100	100	100	67	100	100	100	100		
Overall Column Mean Reliability		100	100	83	100	92	100	83	100	86	100	100		
Ear													92	
Shoulder													92	
Sitting													100	

Overall interobserver reliability. Interobserver reliability for stability: asymmetry across all behavior descriptors and all subjects ranged from 76% to 98% with a grand mean reliability of 87% (see Table 1). The interobserver reliability for stability: cumulative duration across all behavior descriptors and all subjects was 100% (see Table 2).

The interobserver reliability for protective extension forward ranged from 0% to 100% across behavior descriptors and subjects. The grand mean reliability was 91% and 88% for the right arm for the quick and the slow stimulus respectively. The grand mean reliability was 86% for the quick stimulus and 89% for the slow stimulus for the left arm (see Table 3). For protective extension laterally, the reliability ranged from 17% to 100%. The grand mean reliability was 97% for the quick stimulus and 94% for the slow stimulus for the right arm. The grand mean reliability for the left arm was 88% for the quick stimulus and 94% for the slow stimulus (see Table 4). Interobserver reliability for postural fixation across descriptors ranged from 75% to 97% for the response numbers (see Table 5). The row mean reliability, representing the descriptors for stimuli used in postural fixation forward and laterally ranged from 86% to 100% with the grand mean reliability of 96% across trials and subjects.

In the come-to-sit measure, the interobserver reliability scores ranged from 82% to 90% across subjects and across trials with a grand mean of 85% (see Table 6).

Performance Measures

Performance data for stability in sitting, the reflexive base of sitting, and mobility into sitting are presented in Figures 22 to 33. The performance data are presented across trials or sessions.

Subject 1 (P.H.). The performance data for stability: asymmetry (see Figure 22) revealed a high percentage of asymmetry of ear position across all sessions with one trial per session. A trend was noted in a gradual decrease in left side asymmetry with a concurrent increase in right side asymmetry. The bar graph in Figure 23 indicates that the duration of sitting in Trisection II increased across two sessions with the assistance of back support.

The data in Figure 24 demonstrated that the quick stimulus elicited no response (response #1) or a response of shoulder abduction (response #2, i.e., the subject pulled the arms in the opposite direction from breaking his fall) for protective extension forward and laterally. A slow stimulus elicited a higher level of response (e.g., the hand was placed out in the direction to break the fall) for both protective extension forward and laterally across trials. There was no occurrence of the descriptor "breaks the fall" for either protective extension forward or laterally. Performance data consistently showed low levels of response (i.e., response #1 and response #2) for postural fixation forward and laterally (see Figure 25). Excluding the first session, the level of the response increased slightly for the second and third trial within subsequent sessions for postural fixation forward. There was a sporadic increase in the level of the response for three trials noted on the right side for postural fixation laterally.

The performance data for come-to-sit are presented in Figure 26. Figure 26 presents a percentage of the occurrences and nonoccurrences of come-to-sit behaviors across trials (with two trials per session). Using three prompts to assist Subject 1 into sitting, he demonstrated an increase in come-to-sit behavior across sessions.

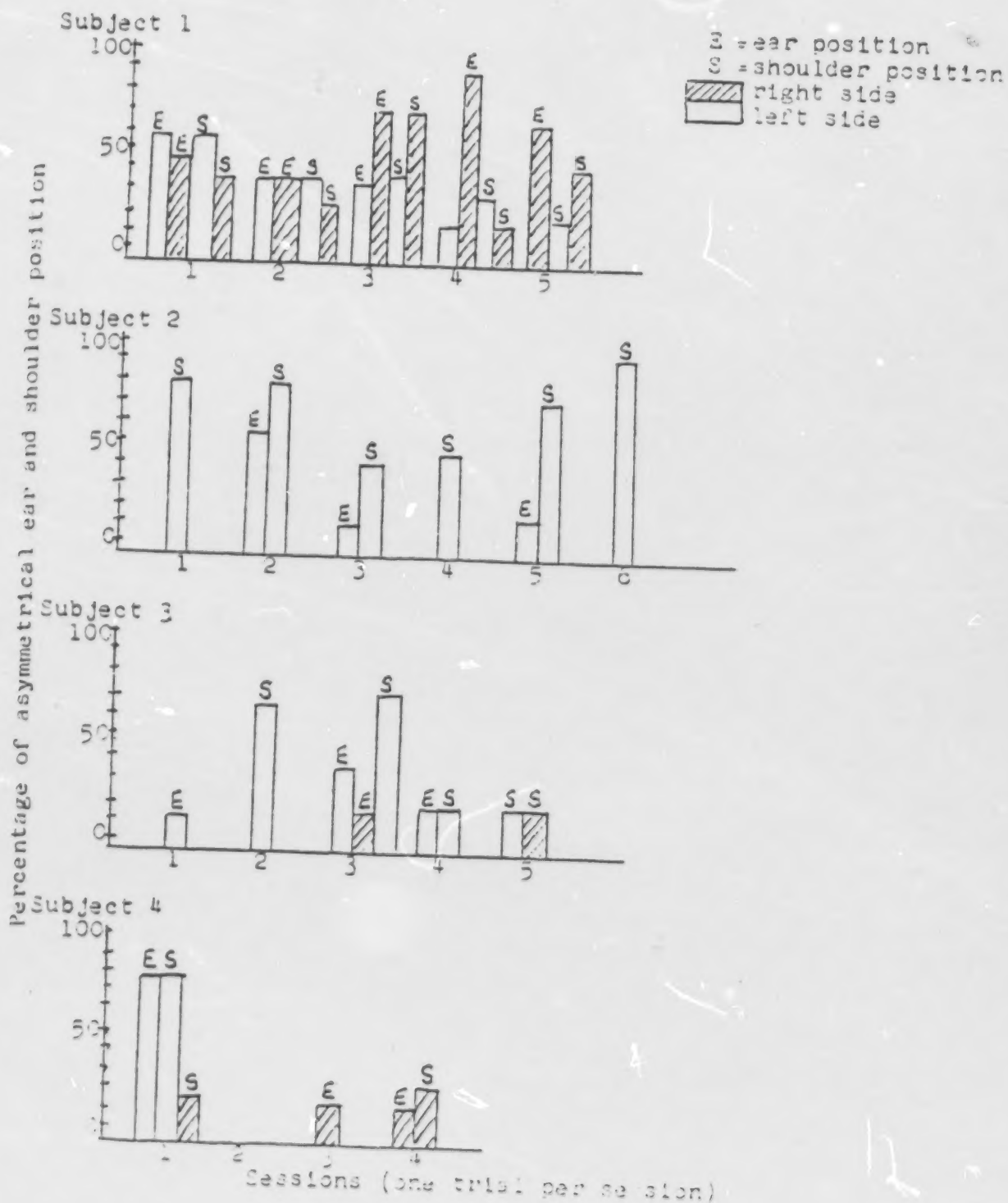


Figure 22. The percentage of asymmetrical ear and shoulder position across sessions for all subjects.

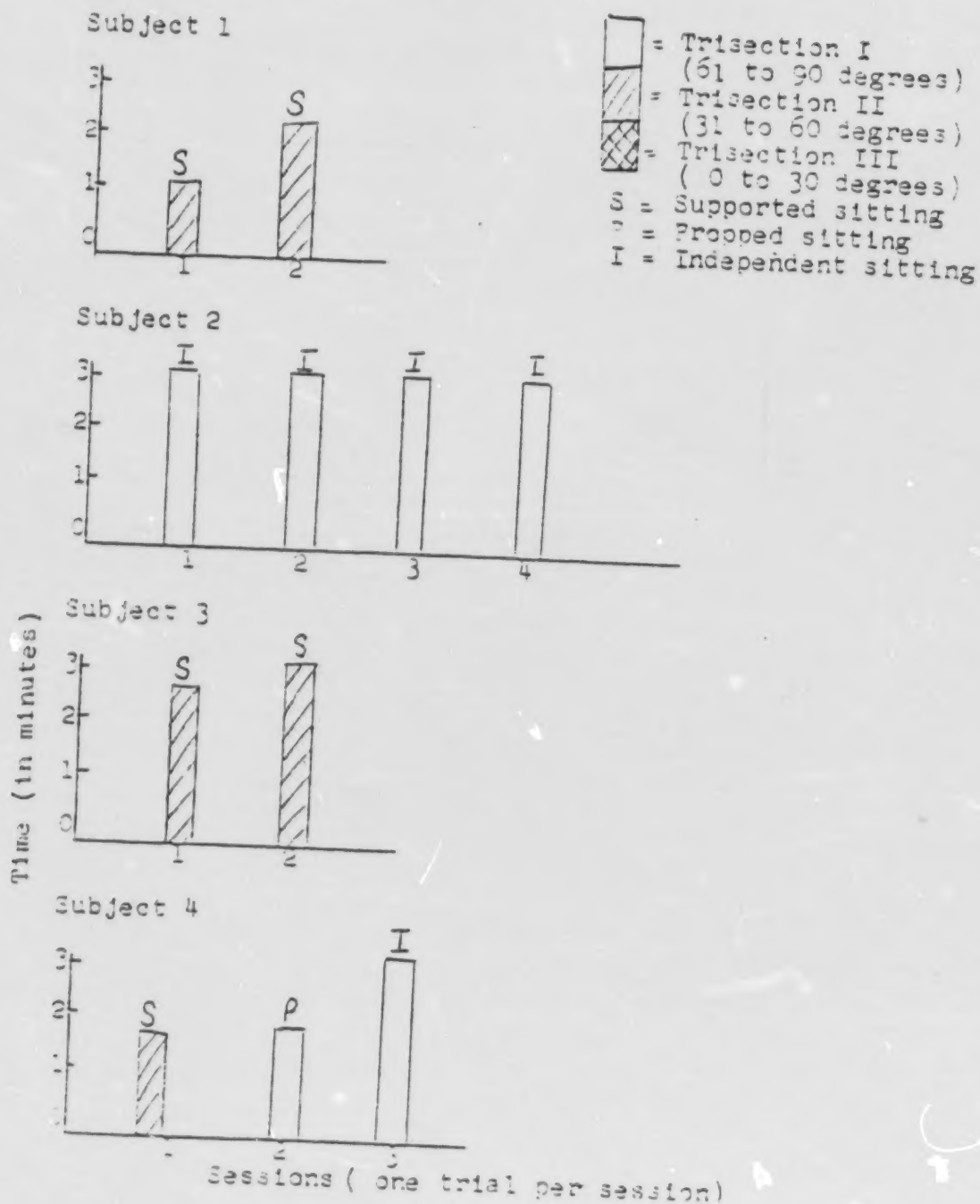


Figure 23. The duration of sitting in trisection I, trisection II, and Trisection III up to a total of 3 minutes for each subject in stability: cumulative duration.

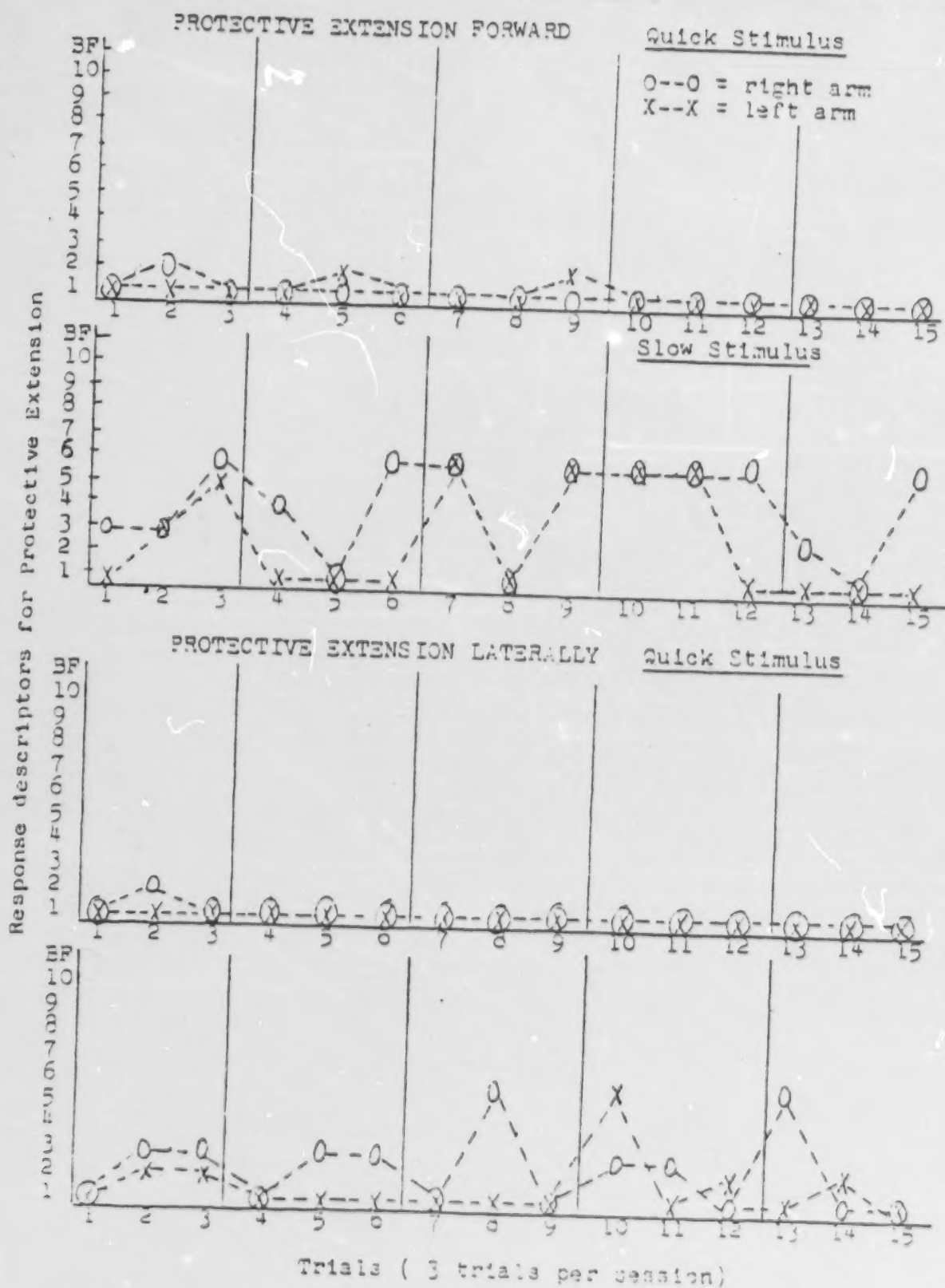


Figure 24. The occurrence of response descriptors for Subject 1 for protective extension.

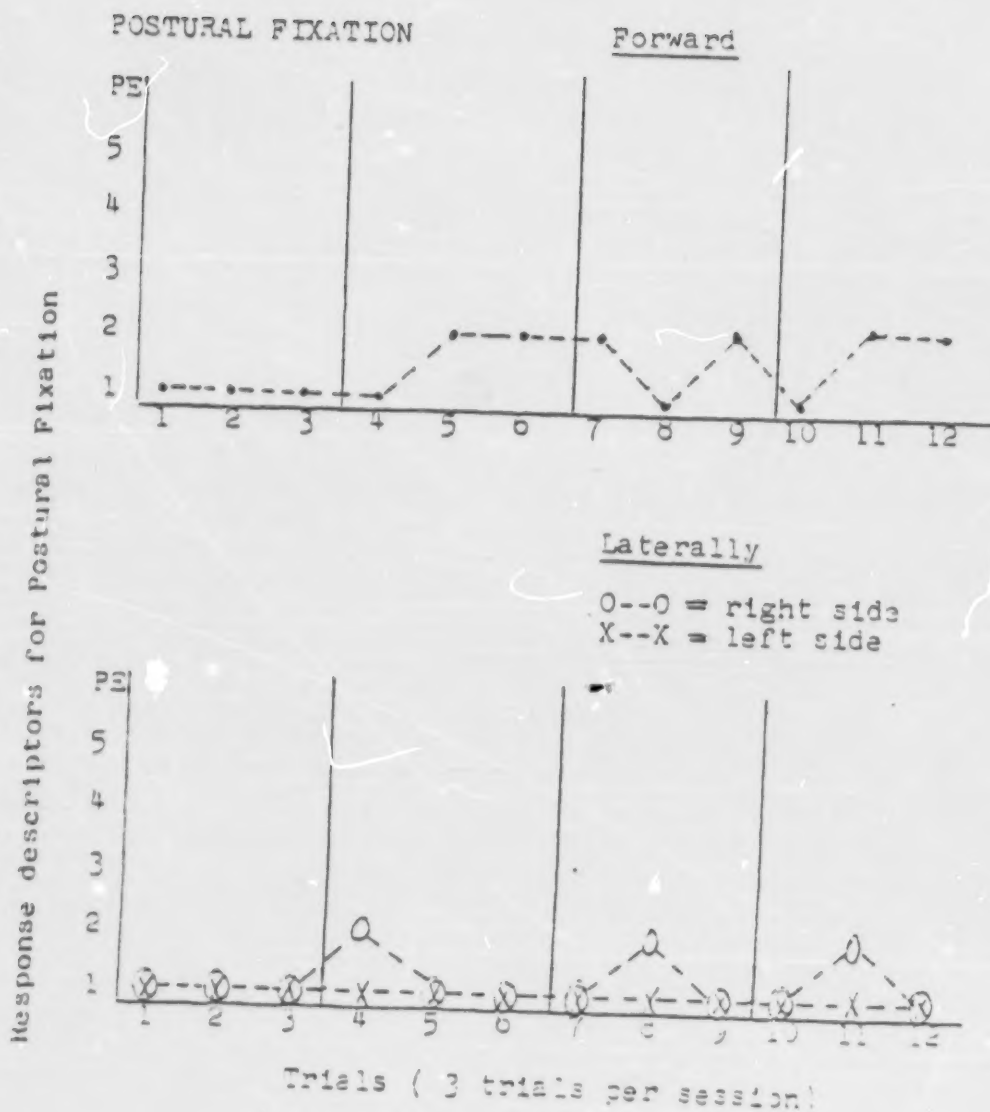


Figure 25. The occurrence of response descriptors for Subject 1 across trials for postural fixation.

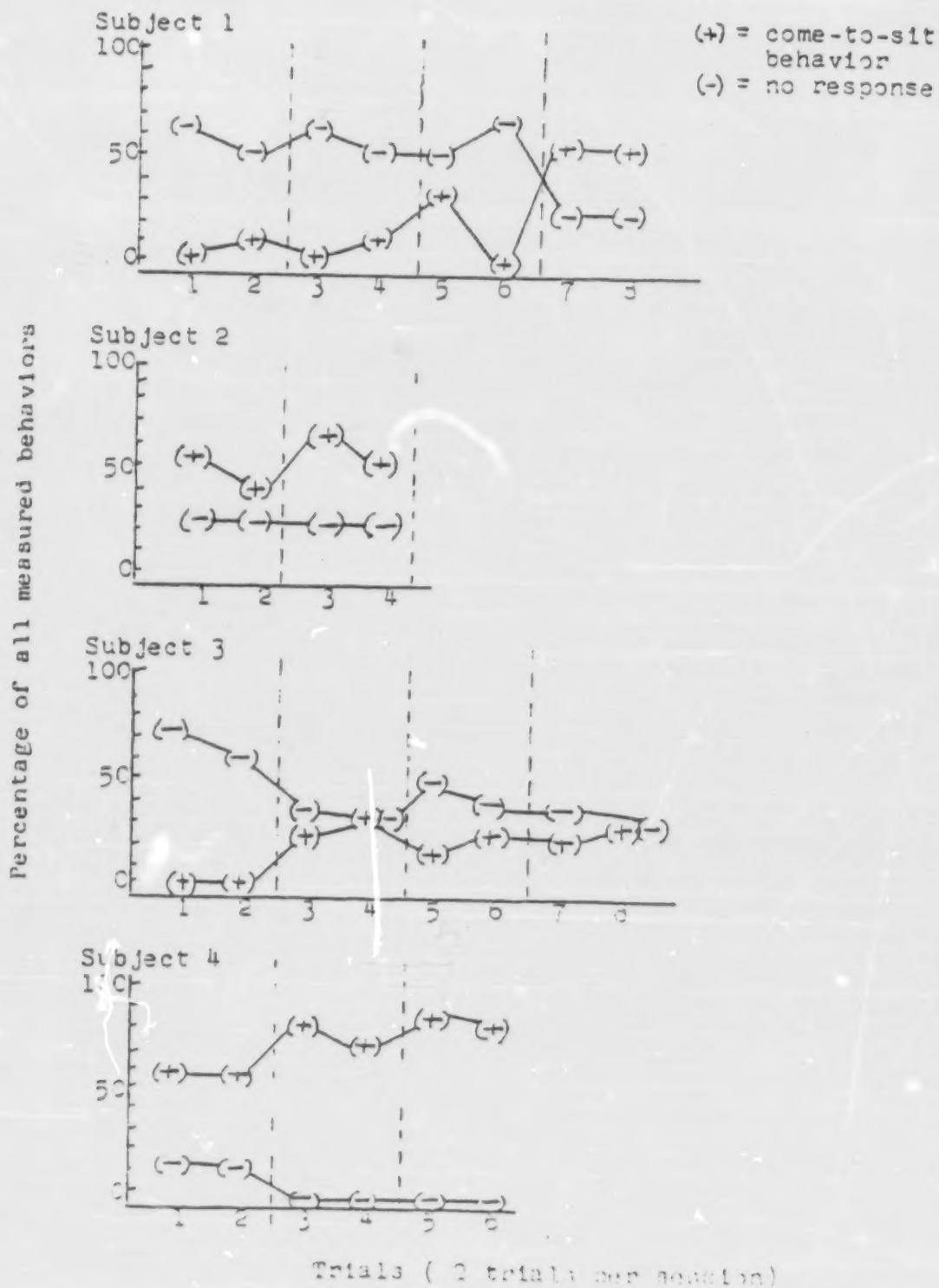


Figure 26. The percentage of come to sit behavior compared to falling or no response for each subject across trials.

Subject 2 (J.B.). The assessment of stability: asymmetry (see Figure 22) revealed consistent left asymmetrical posturing with a higher percentage of shoulder asymmetry than ear asymmetry across sessions and a decreasing trend in ear asymmetry.

Across all four sessions, Subject 2 maintained an erect, independent sitting posture (i.e., sitting at 90 degrees in Trisection I) for each three minute session in the assessment of stability: cumulative duration (see Figure 23).

In protective extension, Subject 2 demonstrated similar responses to both the quick and the slow stimuli (see Figure 27). He demonstrated the response BF (breaking the fall; added after Session 1) in all the sessions (following the revision) except for postural fixation forward using the slow stimulus. The data indicated a generally higher level of response for the left side.

Performance data for postural fixation (see Figure 28) demonstrated the highest level of response (i.e., response #5) across trials and across stimulus conditions. Protective extension was elicited in response to the stimulus for postural fixation on four of the six trials forward and to the left; and on one trial to the right.

Subject 2 demonstrated a higher percentage of come-to-sit behaviors than "no response" behaviors (i.e., 50% compared to 10%) across sessions (see Figure 26).

Subject 3 (M.S.). Figure 22 illustrates that a low level of asymmetry was evident except during the second and third sessions for stability: asymmetry. A comparison of the percentages of asymmetry across sessions demonstrates that the left side was consistently higher.

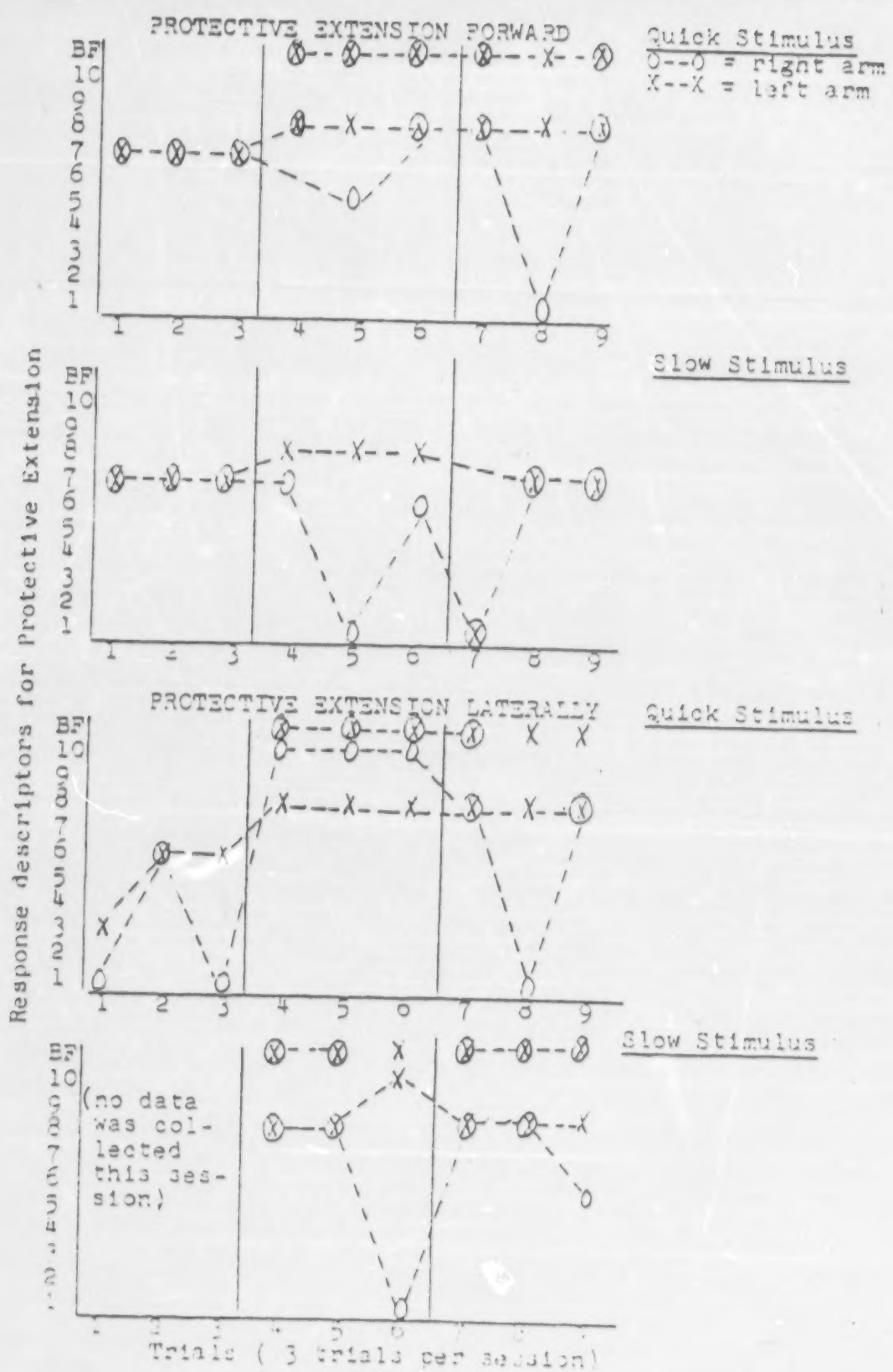


Figure 27. The occurrence of response descriptors for Subject 2 for protective extension.

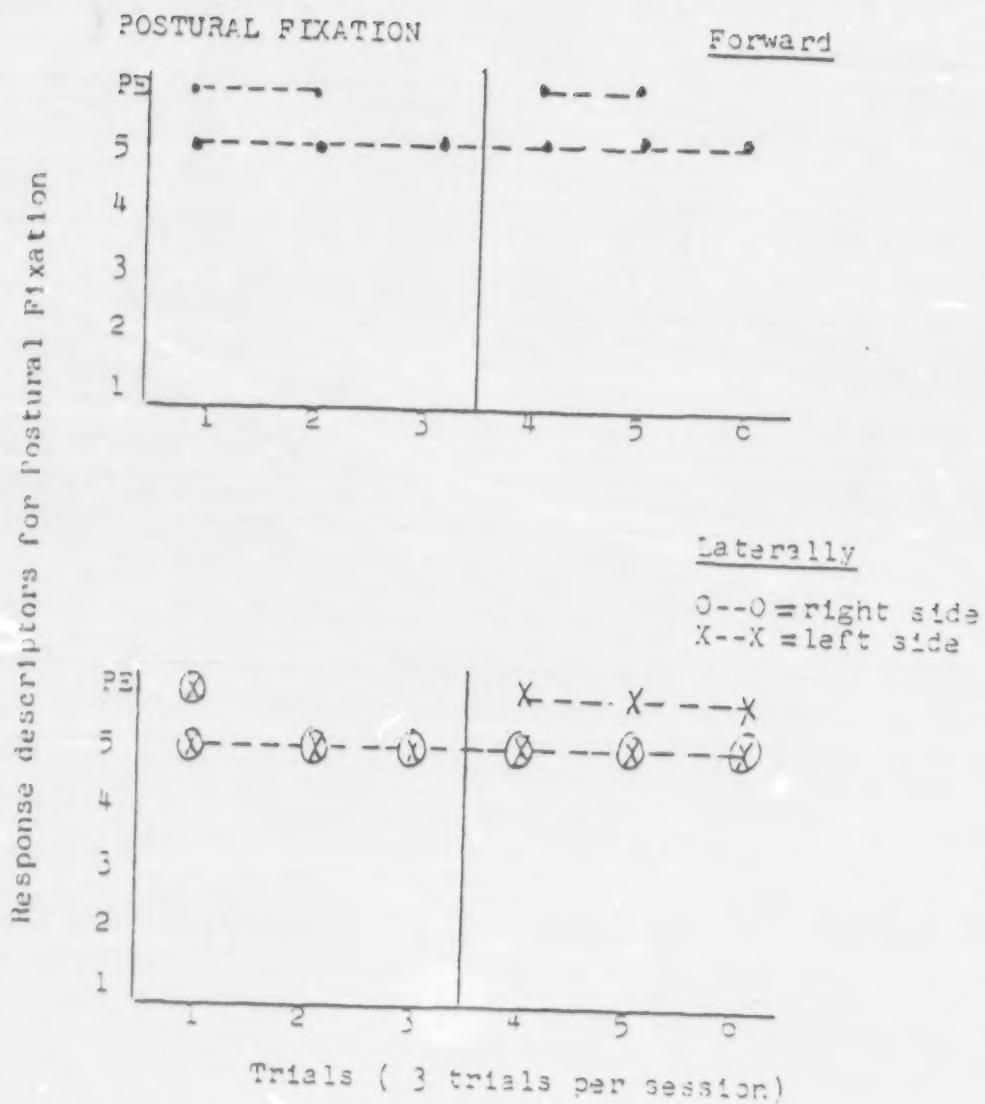


Figure 28. The occurrence of response descriptors for Subject 2 across trials for postural fixation.

In the assessment of stability: cumulative duration (see Figure 23) Subject 3 maintained supported sitting in Trisection II for over 2 minutes in the first session and increased sitting duration to 3 minutes in the final session.

Performance data for protective extension forward demonstrated a wide range of responses (see Figure 29). Responses to a quick stimulus resulted in midrange responses (responses #3 to #6) in the first six trials followed by a drop in response levels. No trend was evident in the performance data for protective extension forward using a slow stimulus. The performance data for protective extension laterally demonstrated sporadic occurrences of low level responses (responses #1 to #3) bilaterally for both the quick and the slow stimuli.

There was no trend in the wide range of responses ranging from the lowest to highest level demonstrated across trials or sessions for postural fixation forward (see Figure 30). Protective extension was not elicited in response to the stimulus for postural fixation forward or laterally. Low level responses for postural fixation laterally were consistently recorded in the first session (see Figure 30). An increase in response level for the right side occurred within the second session. This was followed by consistent high level responses (response #4) for both the right and left arms in the third session and a return to low response levels for both sides in the final session. The right side showed a higher level of response in only two of the twelve trials.

An increasing trend was noted across trials in come-to-sit behavior with a proportionate decrease in falling or no response (see Figure 26).

Subject 4 (J.H.). The performance data demonstrated a significant percentage of left-sided asymmetry (more than 70%) during the first session, and only minimal right-sided asymmetry in subsequent sessions (see Figure 22).

Response descriptors for Protective Extension

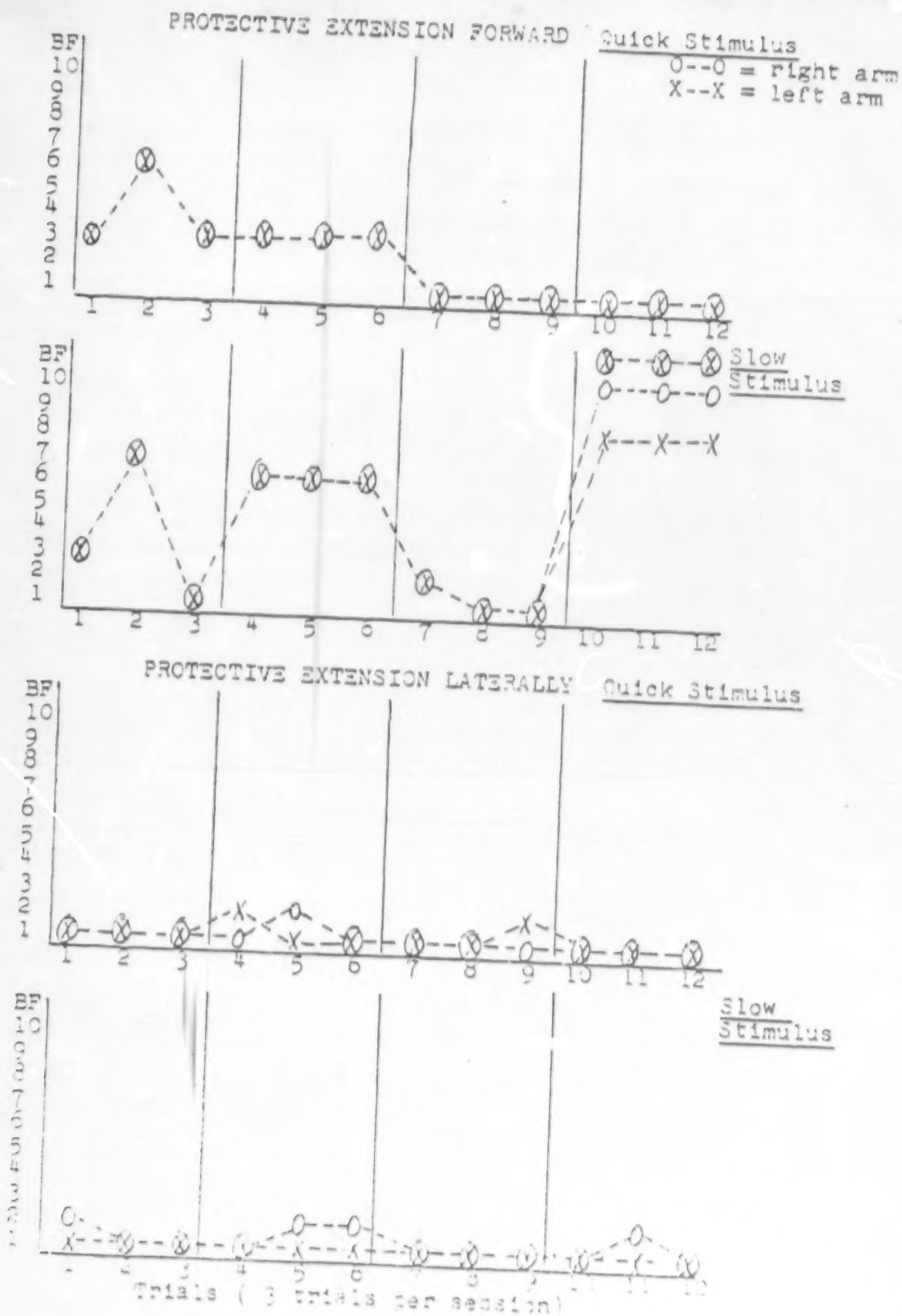


Figure 29. The occurrence of response descriptors for Subject 3 for protective extension.

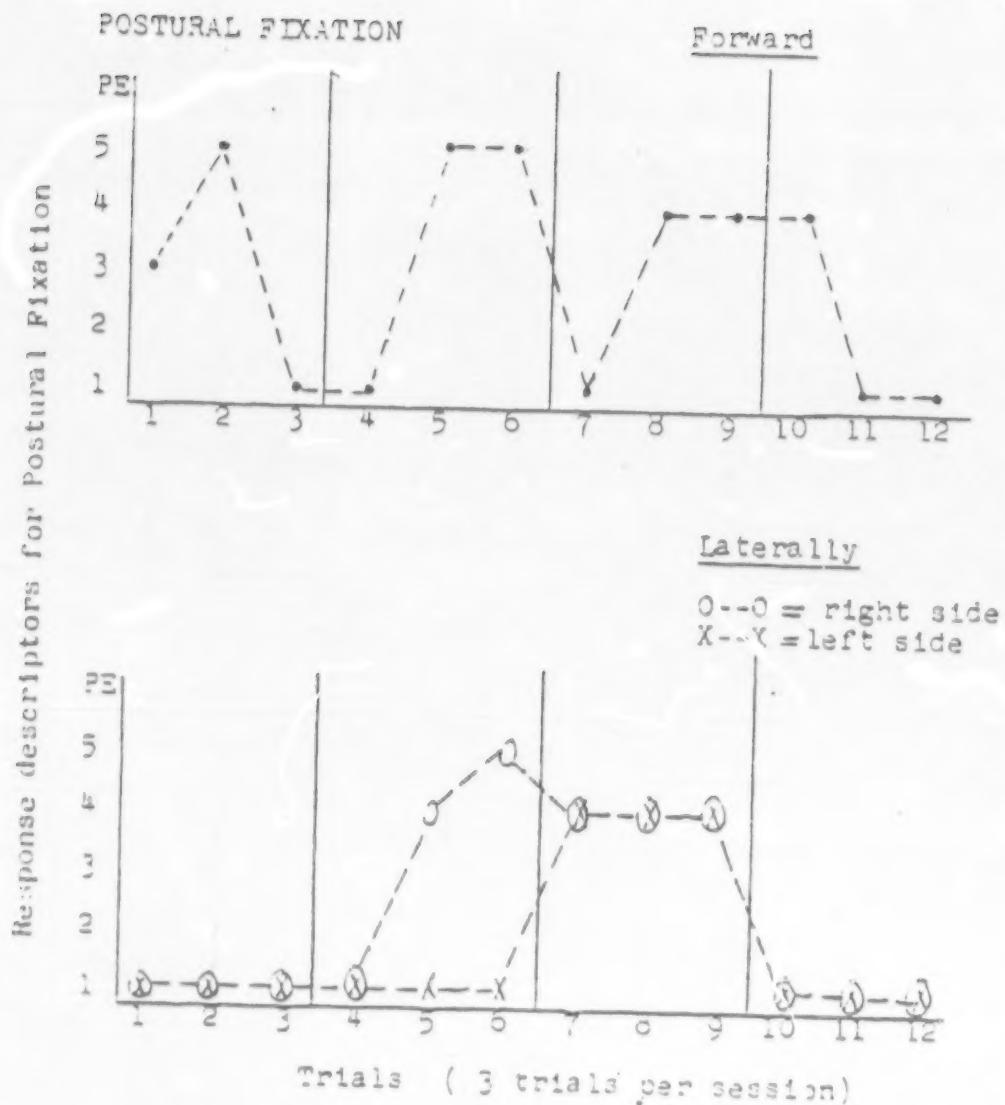


Figure 30. The occurrence of response descriptors for Subject 3 across trials for postural fixation.

In the assessment of stability: cumulative duration, a trend was noted in the increasing duration in sitting (from less than 2 minutes to 3 minutes) as well as the decreasing amount of support needed (from supported to independent sitting) by the subject to maintain the sitting position (see Figure 23).

In Figure 31 consistent high levels of response (responses #8 to #10) of protective extension forward and laterally for both the quick and the slow stimuli were recorded for both arms. In protective extension laterally, increasing trends were observed for each arm in response to a quick stimulus. Subject 4 was able to "break the fall" across all trials in response to both the quick and the slow stimuli for protective extension forward and laterally.

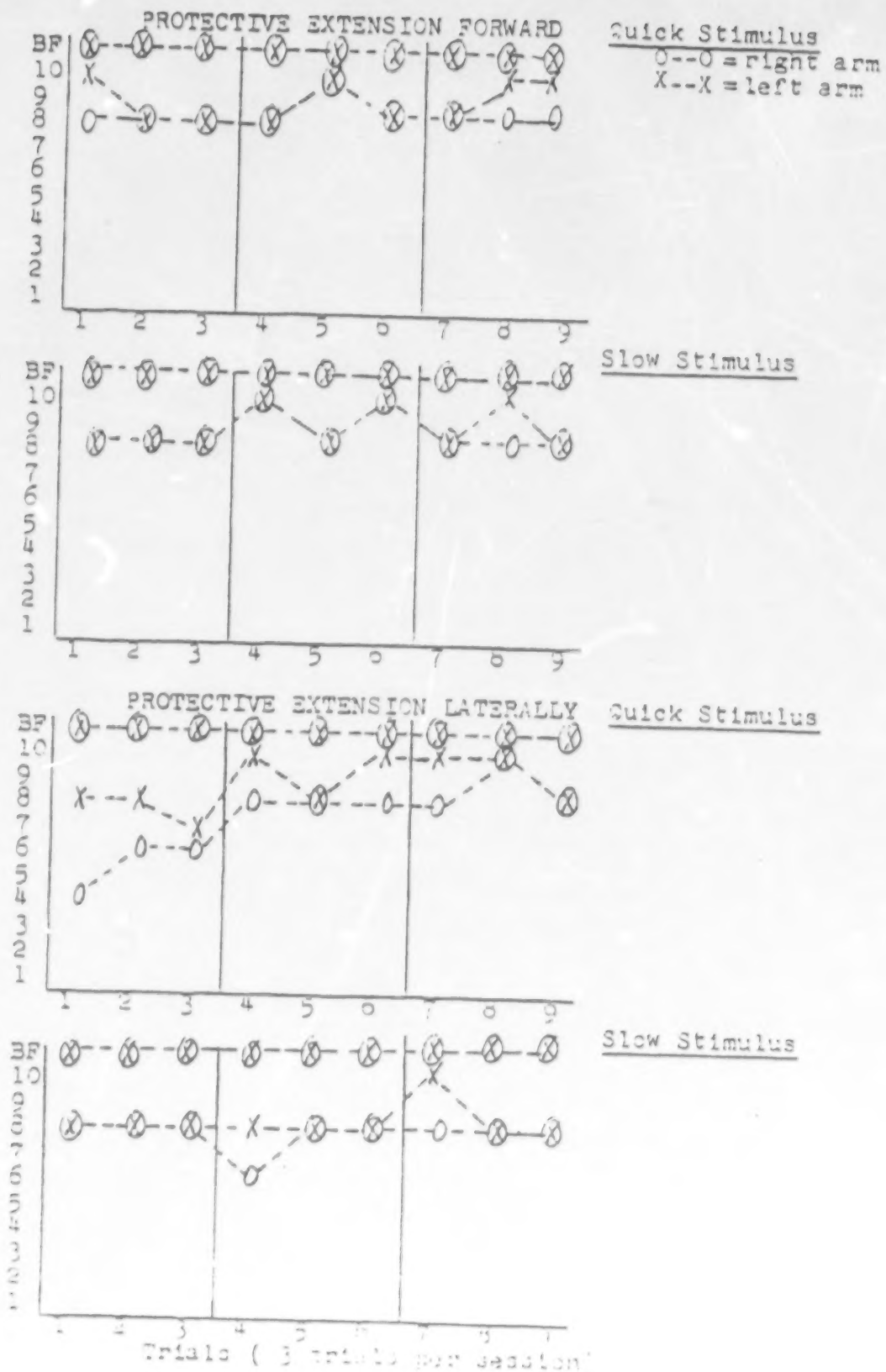
In the assessment of postural fixation forward and laterally (see Figure 32), Subject 4 demonstrated a consistently high level of response across all trials. Protective extension was used only in the second and third trials in response to the stimulus for postural fixation laterally.

On the final measure, come to sit (see Figure 26), as the percentage of come-to-sit behaviors increased, the percentage of falling or no response decreased.

Discussion

The results from these assessment procedures have various implications for classroom teachers and therapists. A quantifiable measure of sitting behavior with sufficiently small increments could be used to determine the effectiveness of therapeutic positioning programs and developmental activities.

Because many of the children who are handicapped require adapted wheelchairs for their educational or home environments, these measures are useful in identifying children who might require more support in



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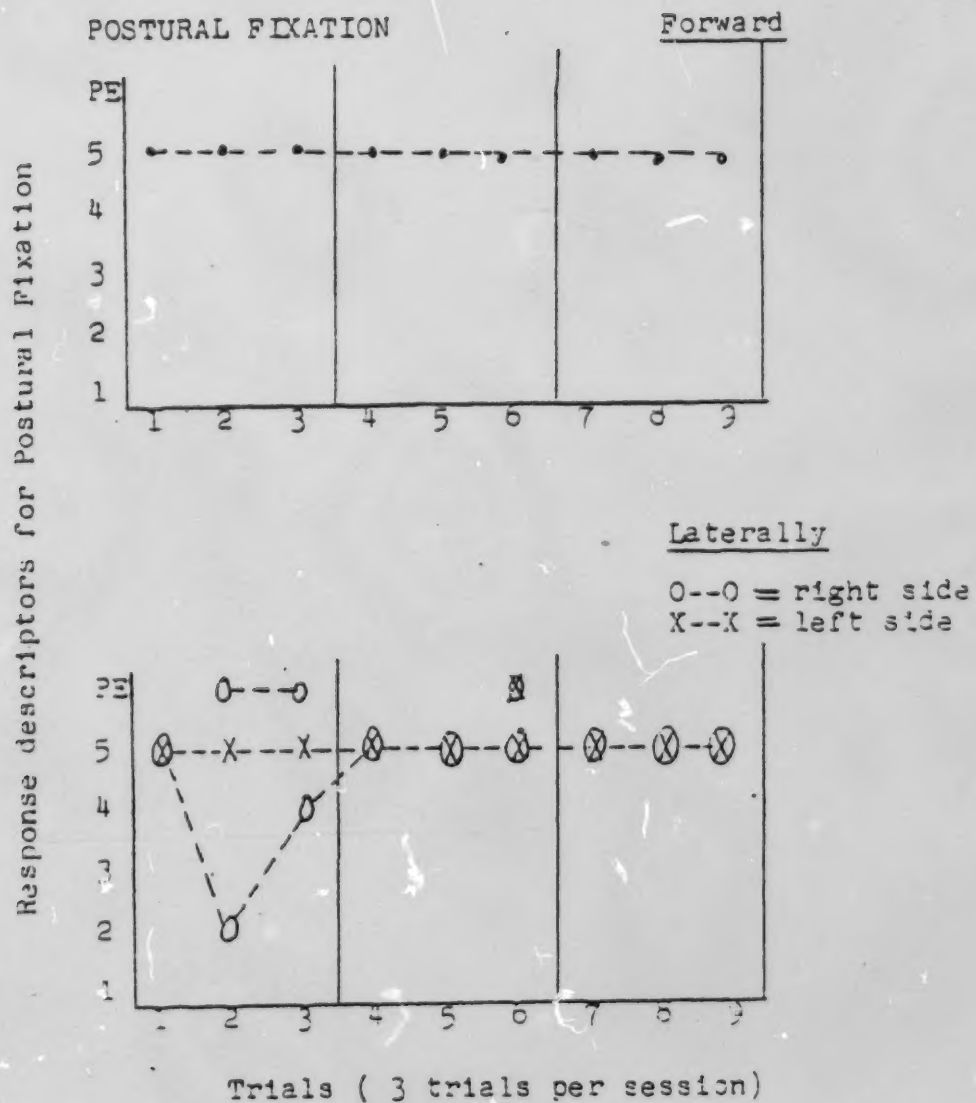


Figure 32. The occurrence of response descriptors for Subject 4 across trials for postural fixation.

their wheelchair positioning. For children with any asymmetry in their sitting posture, appropriate adaptations could be devised to prevent long-term structural problems such as scoliosis or kyphosis.

Each assessment procedure required less than 10 minutes to administer. The test could be administered by one person. Additional observers or assistants, however, might aid in the management of the child's behavior. Their presence would also allow the examiner to attend solely to the motor responses of the child, possibly improving the reliability of the measure.

The measures for protective extension would be useful in providing a safe environment for the child by indicating precautions for positioning the child in appropriate sitting postures.

The measure for come-to-sit provides a prompt procedure which could be used to train a child to move into sitting from a sidelying position.

A REPLICATION STUDY:
Quantitative Assessment of Walking Behavior Among
Severely Handicapped and Nonhandicapped Infants and Children¹

by
Teresa Vernon Foss
and
Mary Jo Noonan

¹ The procedures and data reported in this study were taken from a Master's thesis by Teresa Vernon Foss that was submitted to the Department of Special Education, University of Kansas, in 1980.

Overview of Measurement Procedures

Volume I, Assessment Procedures for Selected Developmental Milestones, pages M(W)1 to M(W) 21, described the measurement procedures used in the original walking study (Sheperd & Lehr, 1980). The procedures developed measured the behaviors of pull to stand from the floor, standing, and walking. Performance and reliability results from the original study are presented in Volume II, pages M(W)1 to M(W)12.

Measurement Procedure Revisions

Most of the measurement procedures used in the original study were also used in this replication study, however, some minor revisions were made. The changes in measurement procedures simplified the needed equipment, refined behavioral descriptions of responses, and reduced several time-based measures that occurred infrequently to occurrence/non-occurrence or short frequency measures.

Pull to stand. Pull to stand, measured whether the child pulled to stand within thirty seconds using a half kneel position, using an extended leg position, or failed to pull to stand. Leg positions were measured with the child positioned in proximity to three different types of equipment: an adjustable table; an adjustable bar or rail attached to a wall; and the side of a crib. The equipment was used to assess pull to stand as a function of the placement or grip of the child's hands.

This replication study contained three trials utilizing only one piece of equipment, a small chair. Since the chair provided the child with all of the types of surfaces for hand placement and grip, it was

felt that the same functions were served as in the earlier study. The three surfaces were necessary to allow the child to select the preferred placement of each hand on: a vertical grip, a horizontal grip, or a flat surface.

Measurements of leg positions in the original study involved recording whether the child used a half kneel position or an extended leg position. The replication study included a recording of flexion or hyperextension, in the right or left leg, and which leg led the half kneel.

In the replication study, the measurement of the base of support was moved from the standing and cruising section to the pull to stand section so that the base of support could be assessed immediately upon the achievement of an upright stance. Rather than tracing the child's feet, the observer noted a description of how the child stood on each foot. The notation consisted of marking whether the child stood (a) on the medial side of the foot; (b) on the lateral side of the foot; (c) on the toe; (d) on the heel; (e) on the full sole; or (f) with the foot continually changing positions.

Standing. Standing included measurements of independent and assisted standing. The types of assistance noted included: two hands held, one hand held, or table support. Other components of this category included measurement of the child's base of support (made by tracing the child's feet on paper); the position of the child's legs (either flexed or extended); bouncing; and stepping up and down, and/or sideways (cruising).

Several changes in the original procedures for measuring standing were made. The measurement of required assistance was changed to include a notation of the particular hand held in the "one hand held" observation.

As previously mentioned, the base of support measurement was transferred to the pull to stand section. A column was added to allow the observer to note a neutral leg position for observations of "normal" or correct leg positions. The assessment of bouncing was changed from a time-sampling measure (marking the occurrence or nonoccurrence of bouncing every twenty seconds in a two minute observation period) to marking the occurrence or nonoccurrence of bouncing during the entire period of two minutes. The original data did not reveal any up-and-down stepping, nor did informal observation of several children by the present author; therefore, this measurement was eliminated. Measurements of stepping movements for cruising were reduced from a frequency count of up-and-down steps and side steps, to recording whether or not the child side-stepped five times to the right and/or left.

Walking. The final category in the original procedures dealt with behaviors related to walking. The observer noted whether the child walked independently or whether assistance was required. The types of assistance noted included: two hands held, one hand held, and trunk held. If the child walked independently, the wrist position in relation to the body was noted. The number of steps taken, the distance walked, the duration of the walk, and the average stride length were recorded.

The wrist positions in the original study were categorized as follows: above the ears, between the ears and shoulders, between the shoulders and waist, or between the waist and knees. The first change reduced the options for recording wrist positions; it was only noted whether the wrist position of the child walking independently was above or below the shoulders. In the type of support required in assisted walking, the conditions of "independent," "two hands held," and "one

hand held" were retained; however, the condition "trunk held" was removed. The condition of "one hand held" was further clarified by specifying the hand held for support (left or right).

The replication study combined all three data sheets into one to facilitate the recording of pulling to stand, standing, cruising and walking observations (see Figure 1).

Subjects

Three handicapped children enrolled in a university preschool and one nonhandicapped child were involved in this study. These children were selected for observation because the mobility skills of pulling to stand, standing, and walking seemed to be emerging in their motor repertoires.

Subject 1. Ruth was a normal 9 month old female. She was able to pull to stand, cruise, and walk a short distance with both hands held.

Subject 2. Brad was a 28 month old male with Down's Syndrome. He was able to pull to stand, stand supported, and walk a few feet with two hands held.

Subject 3. Marie was 29 month old female with Down's Syndrome. She was able to come to stand independently, stand unsupported and take some steps independently.

Subject 4. Lu was a 30 month old female diagnosed as having propionic acidemia. She was able to pull to stand, stand unsupported, and walk independently.

Procedures for Obtaining Measures of Reliability

Reliability measures were taken directly from observations of the child. Reliability was computed by using the following formula:

Child's Name _____ Observer _____
 Date _____ Rel. Observer _____

		Trials	1		2		3		R	%
PULL TO STAND	Initial Place-ment of Hands	Independent	L	R	L	R	L	R		
		Flat Surface	L	R	L	R	L	R		
		Vertical Grip	L	R	L	R	L	R		
		Horizontal Gp	L	R	L	R	L	R		
	Leg Position	Flex	L	R	L	R	L	R		
		Hyperextend	L	R	L	R	L	R		
		Lead Leg	L	R	L	R	L	R		
	Foot Position	Medial	L	R	L	R	L	R		
		Lateral	L	R	L	R	L	R		
		Full Sole	L	R	L	R	L	R		
		Toe	L	R	L	R	L	R		
		Heel	L	R	L	R	L	R		
		Changing	L	R	L	R	L	R		
	Did Not Stand									
STANDING OR CRUISING	Place-ment of Hands	Independent	L	R	L	R	L	R		
		Flat Surface	L	R	L	R	L	R		
		Hand Held	L	R	L	R	L	R		
	Initial Leg Position	Flex	L	R	L	R	L	R		
		Hyperextend	L	R	L	R	L	R		
		Neutral	L	R	L	R	L	R		
	Bouncing	Occurrence	Y	N	Y	N	Y	N		
	5 Side	5 Side Steps L	Y	N	Y	N	Y	N		
5 Side Steps R		Y	N	Y	N	Y	N			
Stand	Duration in sec									
WALKING	Initial Place-ment of Hands	Independent	L	R	L	R	L	R		
		Above Shoulder	L	R	L	R	L	R		
		Independent Below Shoulder	L	R	L	R	L	R		
		Hand Held	L	R	L	R	L	R		
	Number of Steps									
	Distance Walked (inches)									
	Duration Less than 30"	Y	N	Y	N	Y	N			
	Mean Stride Length (in.)									
Key		(X)-Observed Behavior (O)-Disagreement Between Observers								

Figure 1. Data sheet.

$$\frac{\# \text{ of agreements}}{\# \text{ of agreements} + \text{disagreements}} \times 100.$$

This represents the number of agreements divided by the number of agreements plus the number of disagreements multiplied by 100. The reliability scores for each trial were then added together and divided by the total number of reliability scores to obtain the mean reliability score for each session. This procedure was repeated for each observational condition.

In the case of reliability across trials that measure duration, the measures were considered reliable if the examiner and the reliability observer's measurements were in agreement within 2 seconds; the measures for that trial were considered in disagreement if the difference was greater than 2 seconds.

Results

Measures of Interobserver Reliability

The interobserver reliability data for each child are presented in Tables 1 to 6 and in Appendices A to L. Tables 1 to 3 present interobserver reliability data for behavior descriptors for individuals and across individuals. Tables 4 to 6 include interobserver reliability data for pull to stand, stand and cruise, and walk for individual children and across children. Interobserver reliability data for pull to stand, stand and cruise, and walk calculated individually across sessions are presented in Appendices A to L.

Subject 1 (Ruth). Interobserver reliability across all behavior descriptors for pull to stand ranged from 83% to 100% with a mean reliability of 92% (see Table 1); for standing and cruising ranged from 50% to 100% with a mean reliability of 94% (see Table 2); and for walking ranged from 88% to 100% with a mean reliability of 97% (see Table 3).

Table 1
Interobserver Reliability Across Behavior Descriptors
of Pull to Stand for Individual Subjects and Across Subjects

Behavior	Reliability for all sessions per subject				Row Mean
Descriptors	1	2	3	4	Reliability
Independent	-	100	100	100	100
Flat surface	89	100	-	100	96
Vertical surface	100	100	-	100	100
Horizontal surface	97	66	-	-	82
Flex	100	100	100	83	96
Hyperextend	83	-	-	-	83
Lead Leg	83	100	95	100	95
Medial	-	-	-	-	-
Lateral	-	-	-	-	-
Full sole	92	76	99	100	92
Toe	92	60	-	100	84
Heel	-	-	-	-	-
Changing	-	91	-	0	46
Column mean reliability	92	88	99	85	Grand mean reliability 91

Table 2
Interobserver Reliability Across Behavior Descriptors
of Standing and Cruising for Individual Subjects and
Across Subjects

Behavior Descriptors	Reliability for all sessions per subject				Row Mean
	1	2	3	4	Reliability
Independent	100	100	-	80	93
Flat Surface	99	100	100	100	100
Hand held	-	-	-	100	100
Flex	50	-	-	-	50
Hyperextend	-	-	-	-	-
Neutral	100	98	100	-	99
Left side step	100	100	100	100	100
Right side step	100	100	100	100	100
Duration	100	100	100	100	100
Column mean reliability	94	100	100	97	Grand mean reliability 98

Table 3
Interobserver Reliability Across Behavior Descriptors
of Walking for Individual Subjects and Across Subjects

Descriptors	Reliability for all sessions per subject				Row Mean
	1	2	3	4	Reliability
Above shoulder	100	100	-	87	96
Below shoulder	88	92	100	100	95
Hand held	98	100	-	-	99
# of steps	97	100	100	100	99
Distance	100	100	100	100	100
Duration	100	100	100	100	100
Column mean reliability	97	99	100	97	Grand mean reliability 98

Table 4
Interobserver Reliability for Pull to Stand
for Individual Subjects and Across Subjects

Subject	Reliability across sessions			Row Mean
	Hands	Legs	Foot	Reliability
1	93	97	92	94
2	98	100	86	94
3	100	98	98	99
4	100	99	97	98
Column mean reliability	98	98	93	Grand mean reliability 96

Table 5
Interobserver Reliability for Standing and Cruising
for Individual Subjects and Across Subjects

Subject	Reliability across sessions					Row Mean
	Hands	Legs	Bouncing	Side steps	Duration	Reliability
1	98	98	100	100	100	99
2	100	98	100	100	100	100
3	100	100	100	100	100	100
4	92	100	100	100	100	99
Column mean reliability	98	99	100	100	100	Grand mean reliability 100

Table 6
Interobserver Reliability for Walking for Individual
Subjects and Across Subjects

Sessions	Reliability per session				Row Mean
	Hands	# of steps	Distance	Duration	Reliability
1	97	97	100	100	99
2	98	100	100	100	100
3	100	100	100	100	100
4	98	100	100	100	100
Column mean reliability	98	99	100	100	Grand mean reliability 100

Subject 2 (Brad). Interobserver reliability for pull to stand ranged from 60% to 100% across all behavior descriptors with a mean reliability of 83% (see Table 1). Interobserver reliability for standing and cruising ranged from 98% to 100% across behavior descriptors with a mean reliability of 100% (see Table 2). Across behavior descriptors for walking, interobserver reliability ranged from 92% to 100% with a mean reliability of 99% (see Table 3).

Subject 3 (Marie). Interobserver reliability across all behavior descriptors for pull to stand ranged from 95% to 100% (see Table 1). Scores of 100% for interobserver reliability across behavior descriptors were obtained for both standing and cruising (see Table 2) and walking (see Table 3).

Subject 4 (Lu). Interobserver reliability for pull to stand ranged from 0% to 100% across all behavior descriptors with a mean reliability of 85% (see Table 1). For standing and cruising, interobserver reliability ranged from 80% to 100% across behavior descriptors with a mean reliability of 97% (see Table 2). Interobserver reliability for walking across behavior descriptors ranged from 87% to 100% with a mean reliability of 97% (see Table 3).

Overall interobserver reliability. Pull to stand interobserver reliability across sessions for all four children for the behavior descriptors of "hands," "legs," and "foot" was 86% or better with a grand mean of 96%; mean reliability for "hands" and "legs" positions were both 98% and mean reliability for "foot" positions was 93% (see Table 4).

Grand mean interobserver reliability for standing and cruising was 100% (see Table 5). Mean scores for all subjects and descriptors were

100% except for the "hands" and "legs" descriptors. Interobserver reliability for "hands" ranged from 92% to 100% with a mean of 98%, and "legs" ranged from 98% to 100% with a mean of 99%.

Interobserver reliability for walking, across children and descriptors, had means ranging from 97% to 100%. The grand mean was 100% (see Table 6).

Performance Measures

The performance data for each child are presented in the graphs in Figures 2 to 21. Figures 2 to 4, 8 to 10, 14, 15, 18, and 19, present performance data for each behavior descriptor of pull to stand, standing and cruising, and walking for the individual children. Figures 5 to 7, 11 to 13, 16, 17, 20, and 21 present performance data for the percentage of occurrence of each behavior descriptor for pull to stand, standing and cruising, and walking for the individual children. Performance data for the placement of hands, leg positions, and foot positions are presented on graphs for both the left and right hand, leg, or foot. The symbols and connecting lines are labeled on each graph and/or figure. Behavior descriptions for foot positions that were never demonstrated are not included on the individual graphs.

Subject 1 (Ruth). Figure 2 presents the occurrence of behaviors in pull to stand per session for 10 sessions. Performance data for Ruth's placement of left hand indicated an increasing trend in horizontal grip accompanied by a decreasing trend in flat surface response in pull to stand. Data for placement of her right hand indicated a decreasing trend in horizontal grip and an increasing trend for the flat surface response. Performance data for the position of the left leg indicated a consistent flexion response. A slightly increasing trend in lead leg responses, as well as a decreasing trend in hyperextension responses for

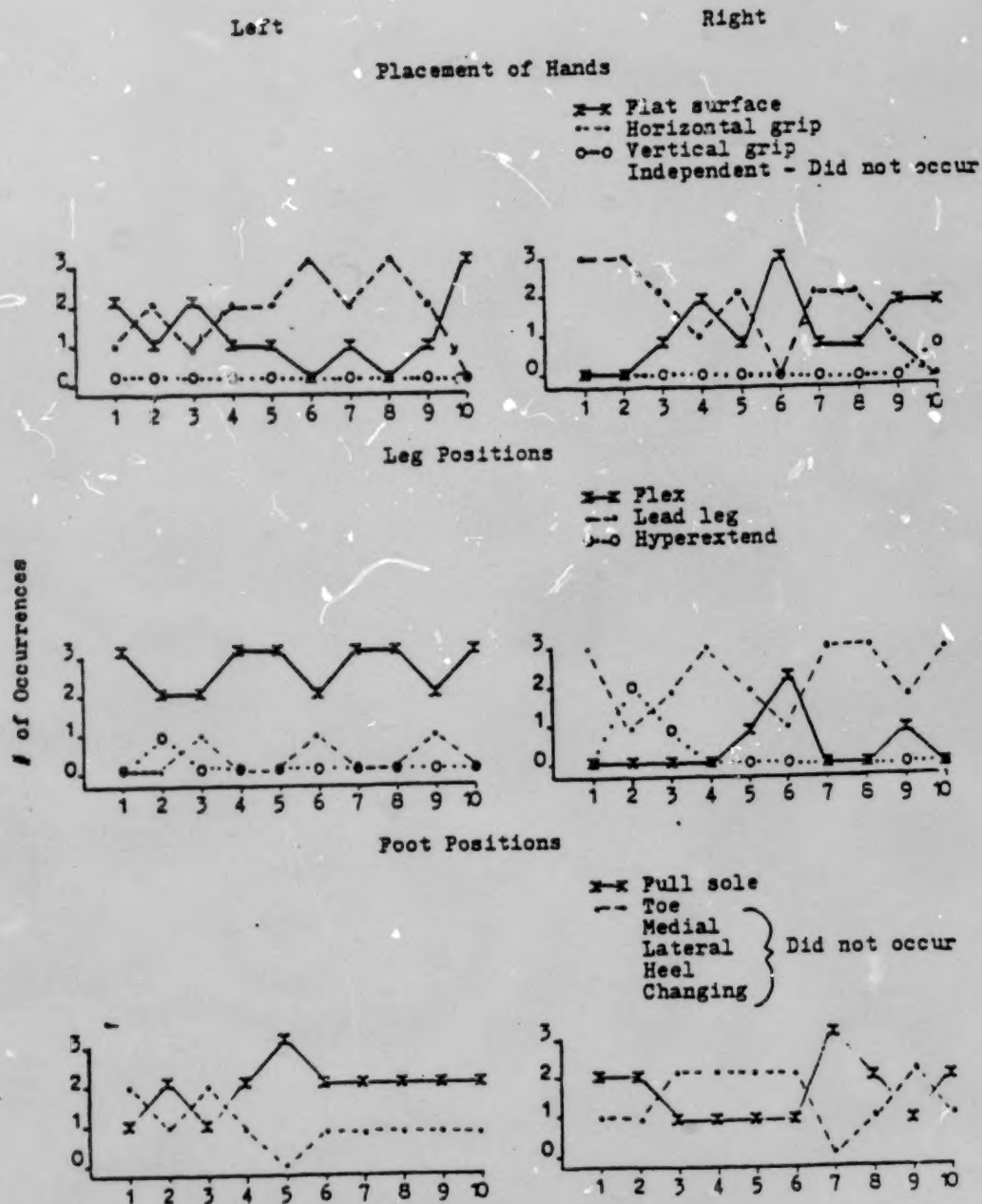


Figure 2. Occurrence of behaviors in pull to stand per session for Ruth.

the right leg occurred. A slightly increasing trend in full sole responses and a decreasing trend for the toe responses are presented for the left foot. The occurrence of toe responses decreased and full sole responses increased for the right foot.

Figure 3 presents the occurrence of behaviors and the total duration of independent stand for standing and cruising. Ruth consistently placed her left hand on a flat surface; the right hand was continually on a flat surface until the last three sessions, when the responses were flat surface and independent. Ruth repeatedly stood with both legs in a neutral position. The total duration of independent stand ranged from 9-41 seconds with a mean of 4 seconds.

Figure 4 presents the occurrence of behaviors, total distance, number of steps, a mean stride length for walking per session for 10 sessions. Performance data showed Ruth's hands were hand held for the first five sessions, and positions varied for the last five sessions. The total distance walked per session ranged from 31 to 151 inches (78.74 to 383.54 cm) with a mean of 36 inches (91.44 cm). There was an increasing trend in mean stride length and total number of steps per session.

Figure 5 presents the percentage of occurrence of behaviors for pull to stand for 10 sessions. The majority of responses in the placement of hands were flat surface and horizontal grip for both hands. In leg positions, the flexion responses occurred most frequently for the left leg and the right leg was usually the lead leg. The full sole foot position, the most frequent foot position, occurred in 63% of the sessions for the left foot and 53% for the right foot.

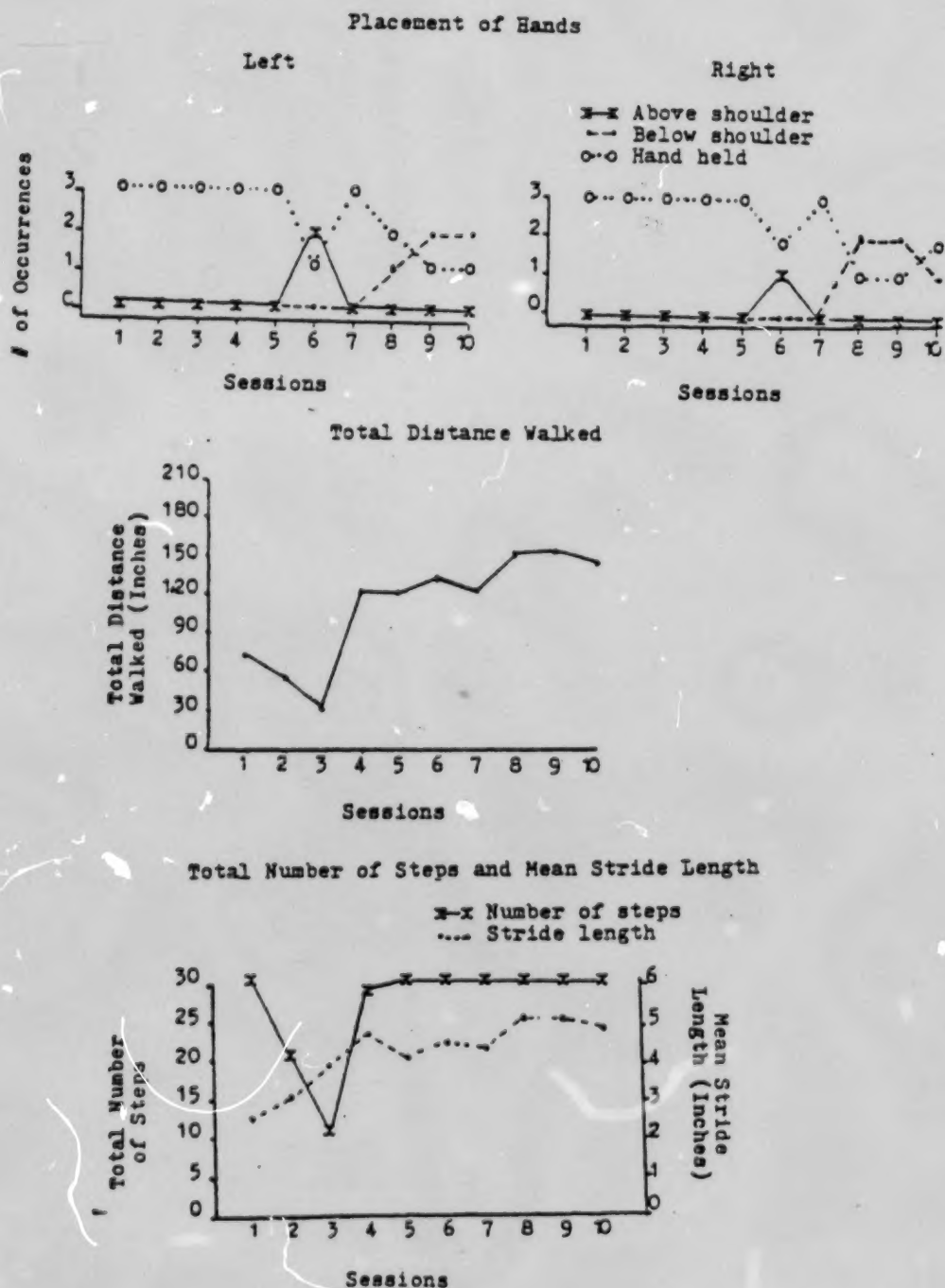


Figure 4. Occurrence of behaviors, total distance walked, total number of steps, and mean stride length for walking per session for Ruth.

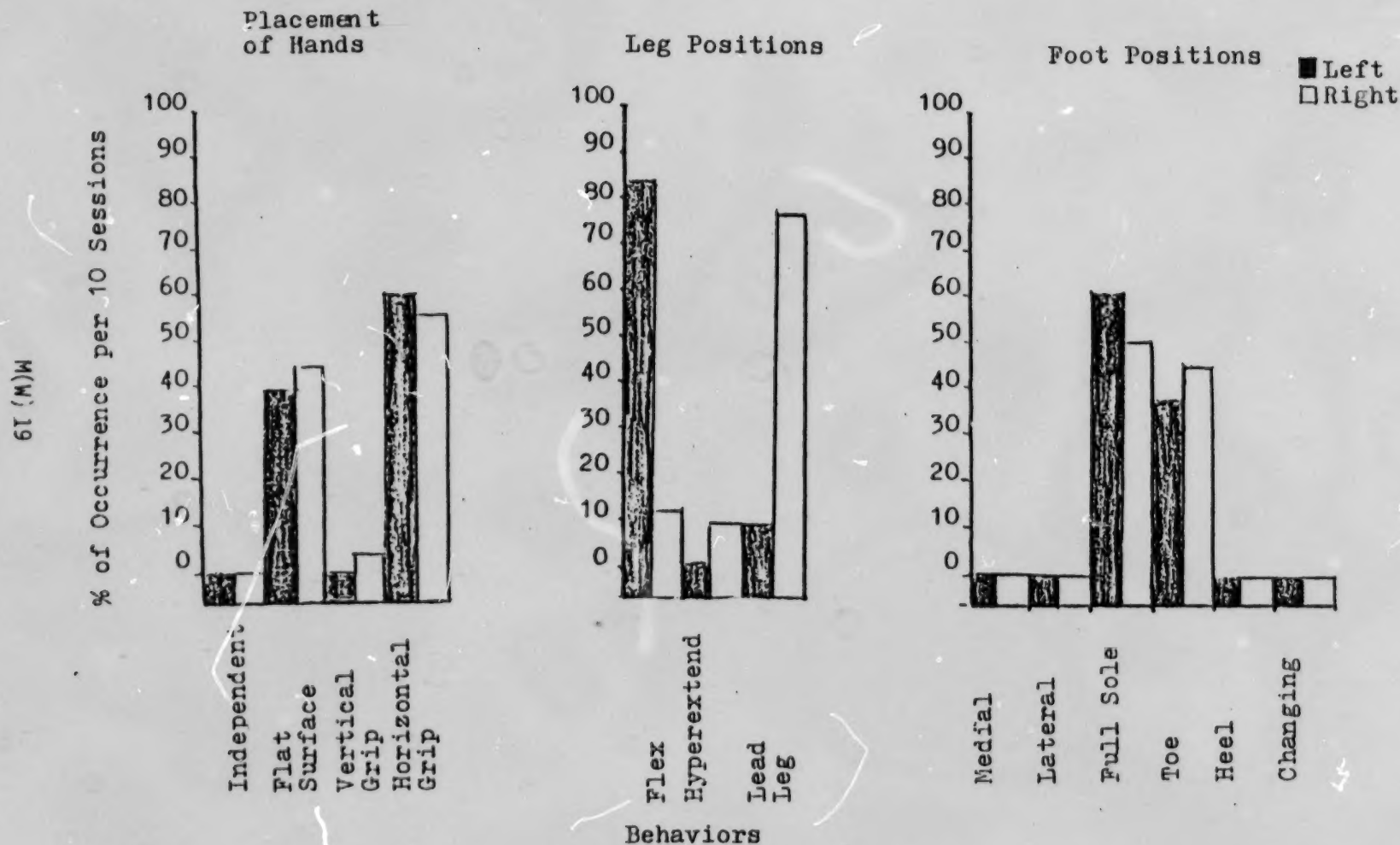


Figure 5 . Percentage of occurrence of behaviors for pull to stand
for total sessions for Ruth.

Figure 6 presents the percentage of occurrence of behaviors for standing and cruising for 10 sessions. The major response in the placement of hands was the flat surface response for both hands. In leg positions, the neutral response occurred in 100% of the sessions for the left leg and 94% for the right. Bouncing occurred in only 4% of the sessions and sidestepping occurred in over 85% of the sessions.

Figure 7 presents the percentage of occurrence of hand placement for walking. The hand held response occurred in 80% of the sessions.

Subject 2 (Brad). Figure 8 presents the occurrence of behaviors in pull to stand per session for 8 sessions. Performance data for Brad's placement of hands indicated an increasing trend in independent come to stand. Concurrently, there was a decreasing trend in flat surface responses of the left hand, as well as a decrease of flat surface and horizontal grip responses of the right hand. Performance data for leg positions indicated a fairly constant flexion response for the left leg, and the lead leg response for the right leg. There was a decreasing trend in toe and changing responses, and an increasing trend in full sole responses for left and right foot positions.

Figure 9 presents the occurrence of behaviors and the total duration of independent stand for standing and cruising. Brad consistently placed both his left and right hand on a flat surface while cruising. Brad stood with both the left and the right leg in a neutral position in each session. The total duration of independent stand ranged from 5 - 13 seconds with a mean of 9 seconds.

Figure 10 presents the occurrence of behaviors, total distance, number of steps, and mean stride length for walking per session for eight sessions. Brad's left hand was held consistently. Independent

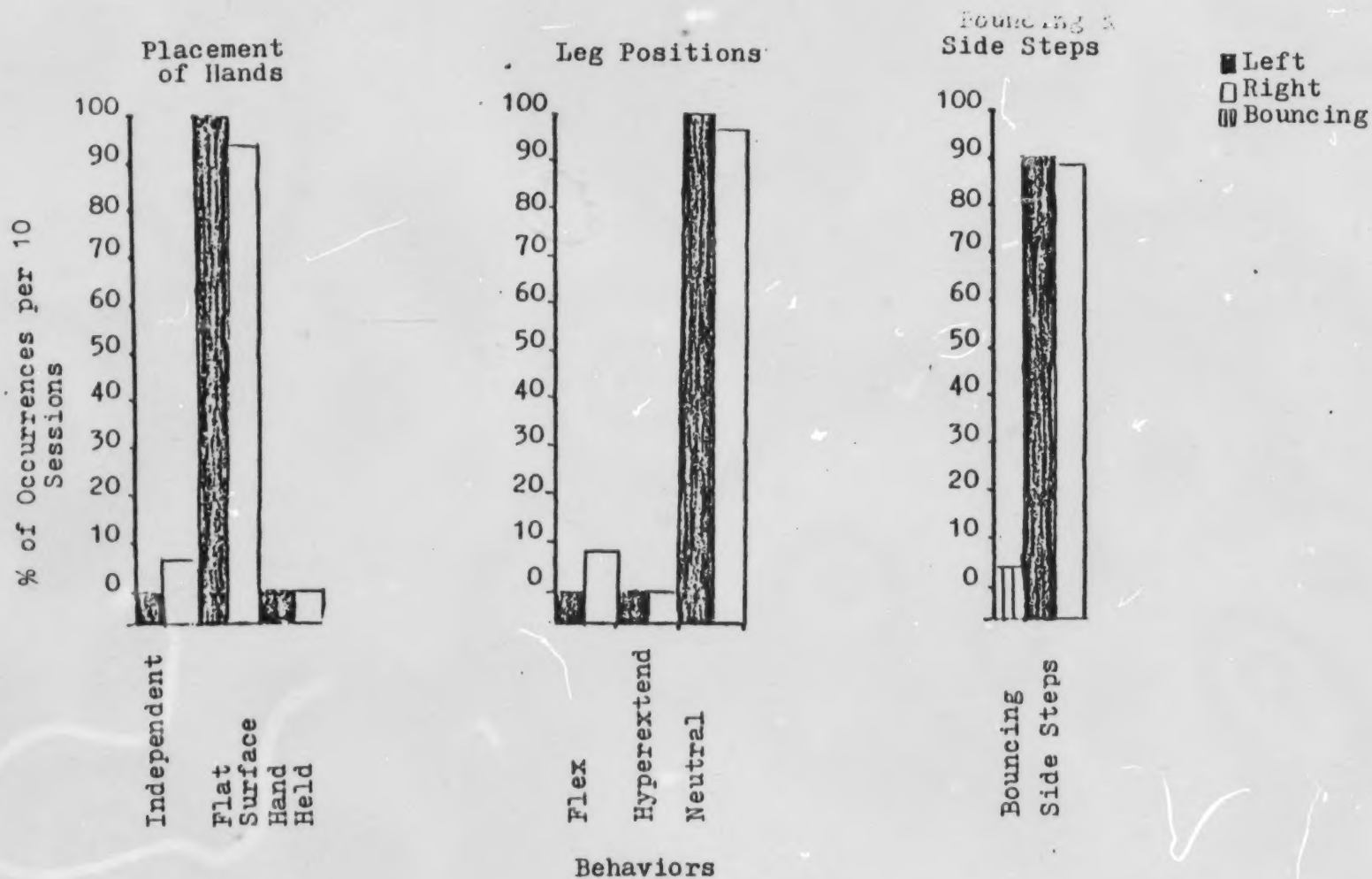


Figure 6. Percentage of occurrence of behaviors for standing and cruising for total sessions for Ruth.

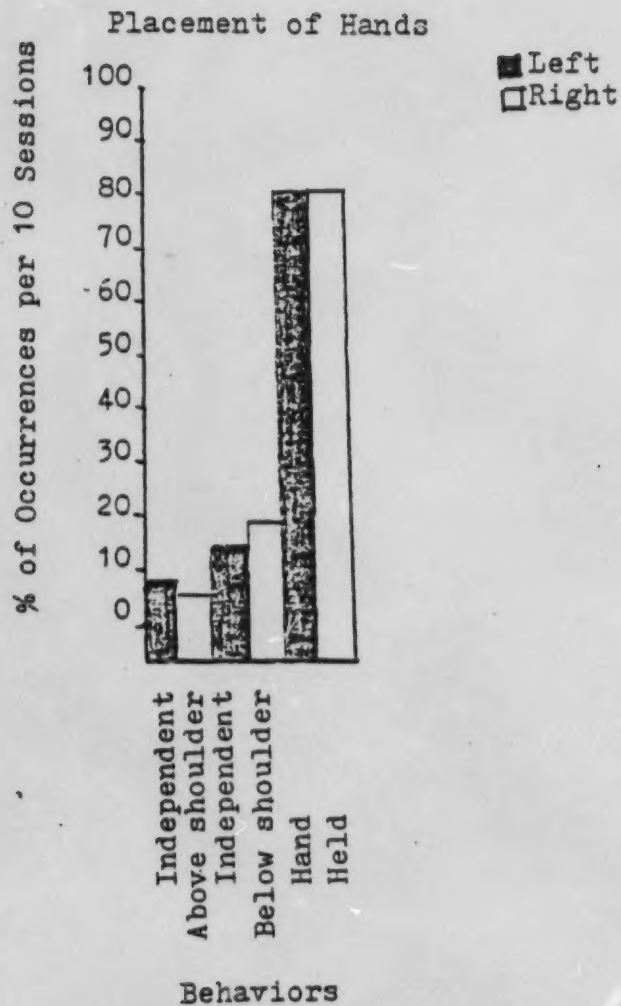


Figure 7. Percentage of occurrence of placement of hands for walking for total sessions for Ruth.

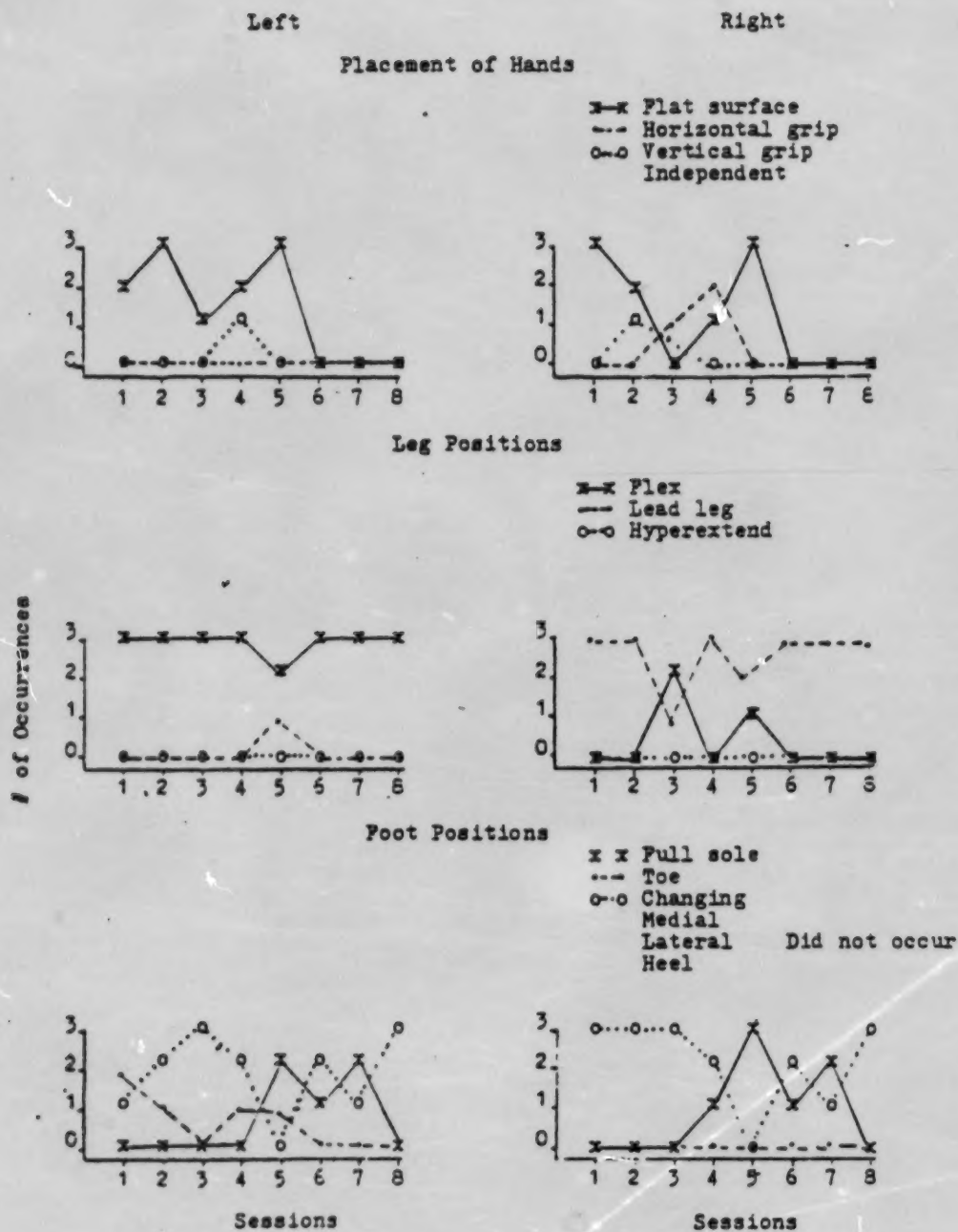


Figure 8. Occurrence of behaviors in pull to stand per session for Brad.

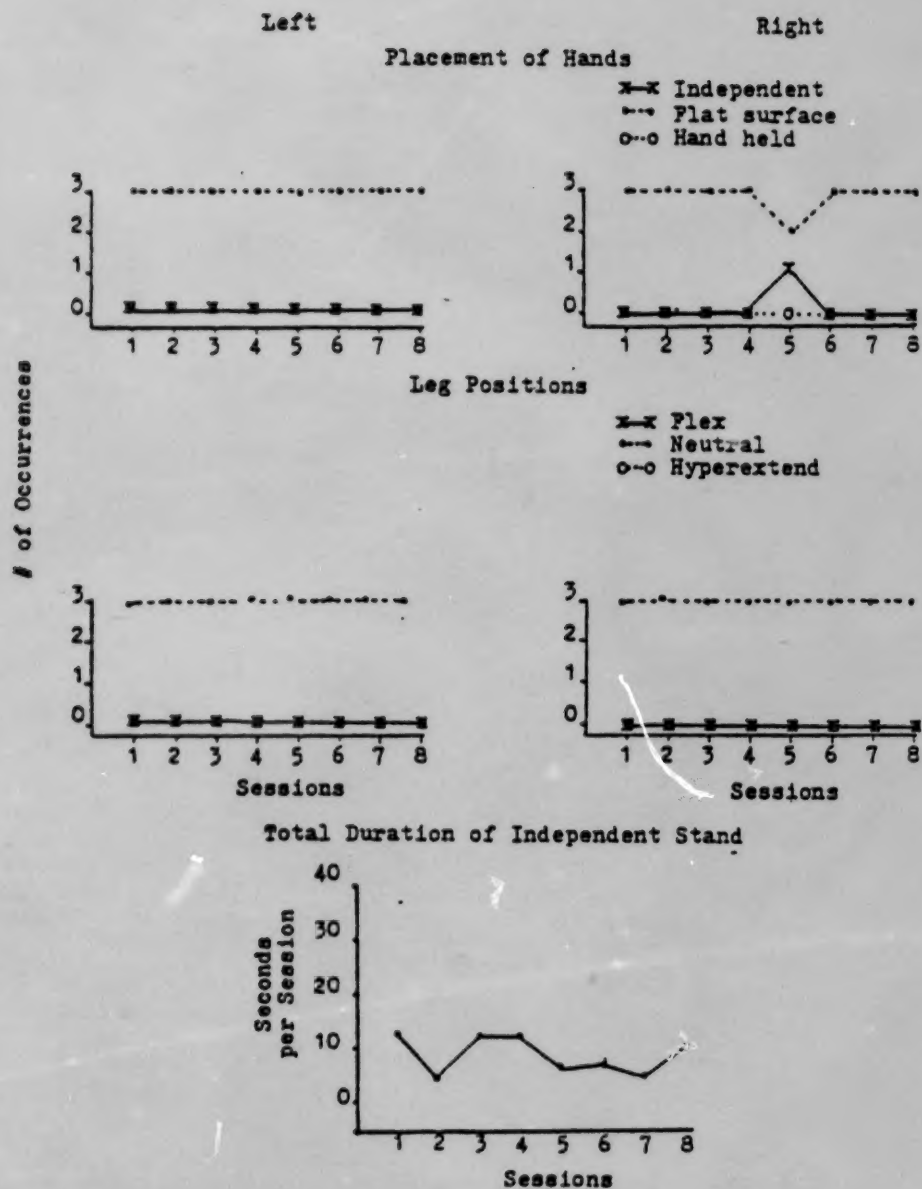


Figure 9. Occurrence of behaviors and total duration of independent stand for standing and cruising per session for Brad.

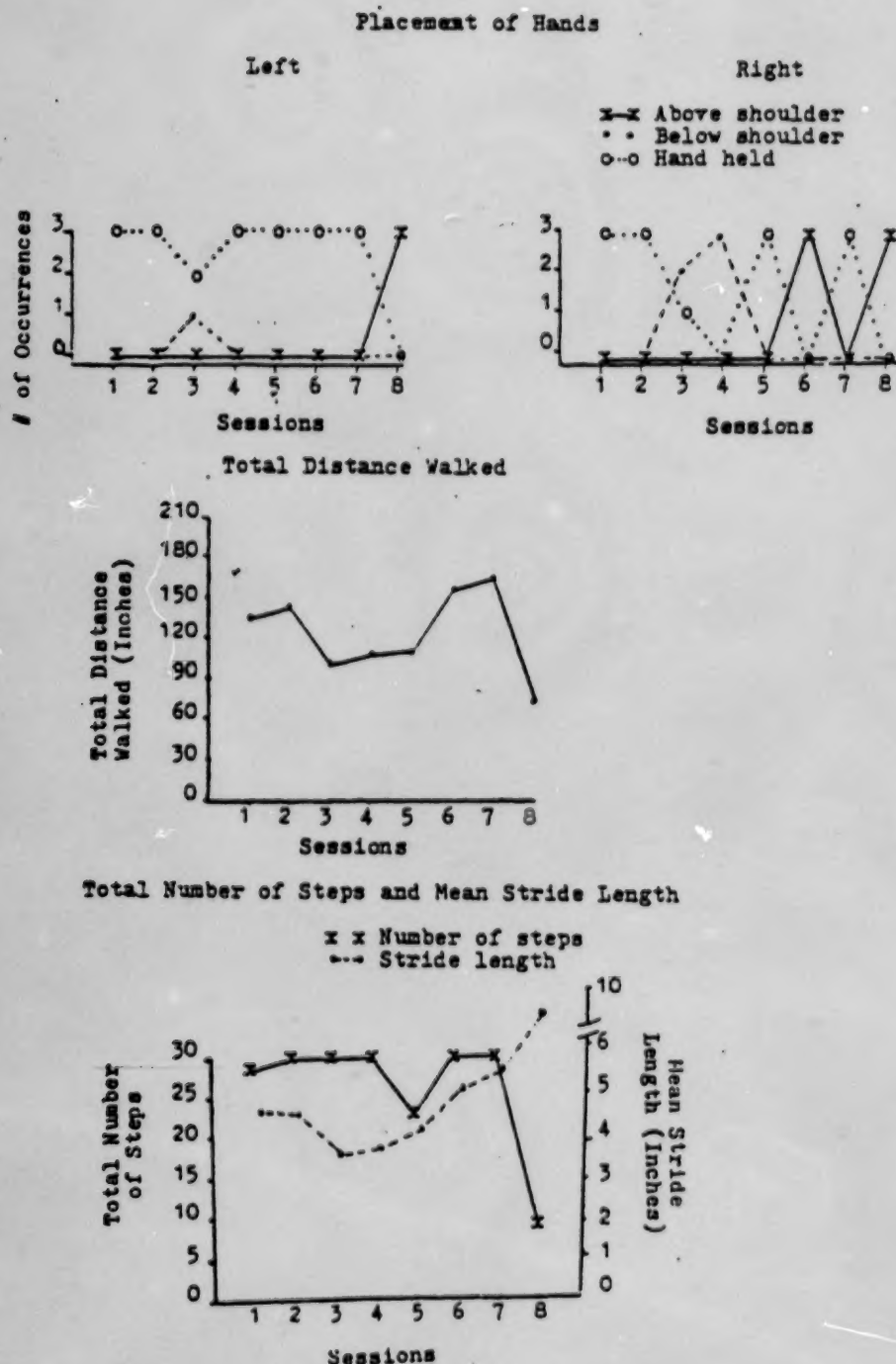


Figure 10. Occurrence of behaviors, total distance, total number of steps, mean stride length for walking for Brad.

hand placement above the shoulder and independent hand placement below the shoulder each occurred once. Responses of the right hand fluctuated, but over time the right hand was consistently held and there was a decreasing trend in independent hand placement below the shoulder and an increasing trend in independent hand placement above the shoulder. The total distance walked per sessions ranged from 83.5 to 168 inches (210.82 to 426.72 cm) with a mean of 129 inches (327.66 cm). There was an increasing trend in mean stride length ranging from 3.7 to 10.2 inches, (9.398 to 25.9 cm) per session accompanied by a decreasing trend in the total number of steps taken per session (ranging from 8 to 30 steps).

Figure 11 presents the percentage of occurrence of behaviors for pull to stand for eight sessions. The majority of responses in the placement of hands were independent and flat surface for both the left and right hand. Across most sessions the left leg was flexed and the right leg was the lead leg in pulling to stand. The majority of foot positions were changing in 58% of the sessions for the left foot and 71% for the right.

Figure 12 presents the percentage of occurrence of behaviors for standing and cruising for eight sessions. The most frequent response in the placement of hands was the flat surface response for both hands. In leg positions, the neutral response occurred in 100% of the sessions. Left and right side stepping occurred in 100% of the sessions.

Figure 13 presents the percentage of occurrence of hand placement for walking; the predominant response was hand held.

Subject 3 (Marie). Figure 14 presents the occurrence of behaviors in pull to stand per session for 10 sessions. Marie continually came to stand independently and required a hand support to achieve an upright

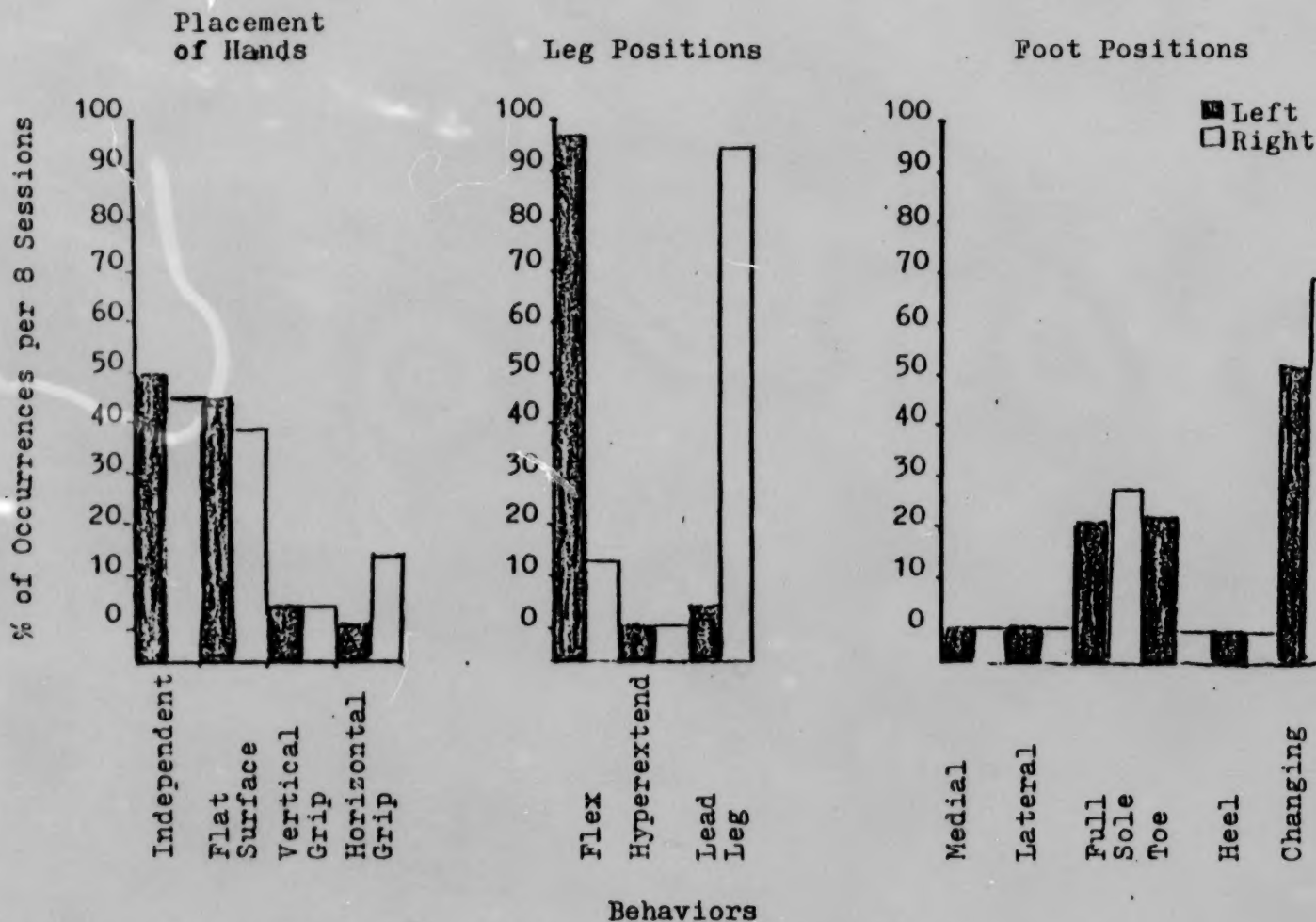


Figure 11. Percentage of occurrence of behaviors for pull to stand for total sessions for Brad.

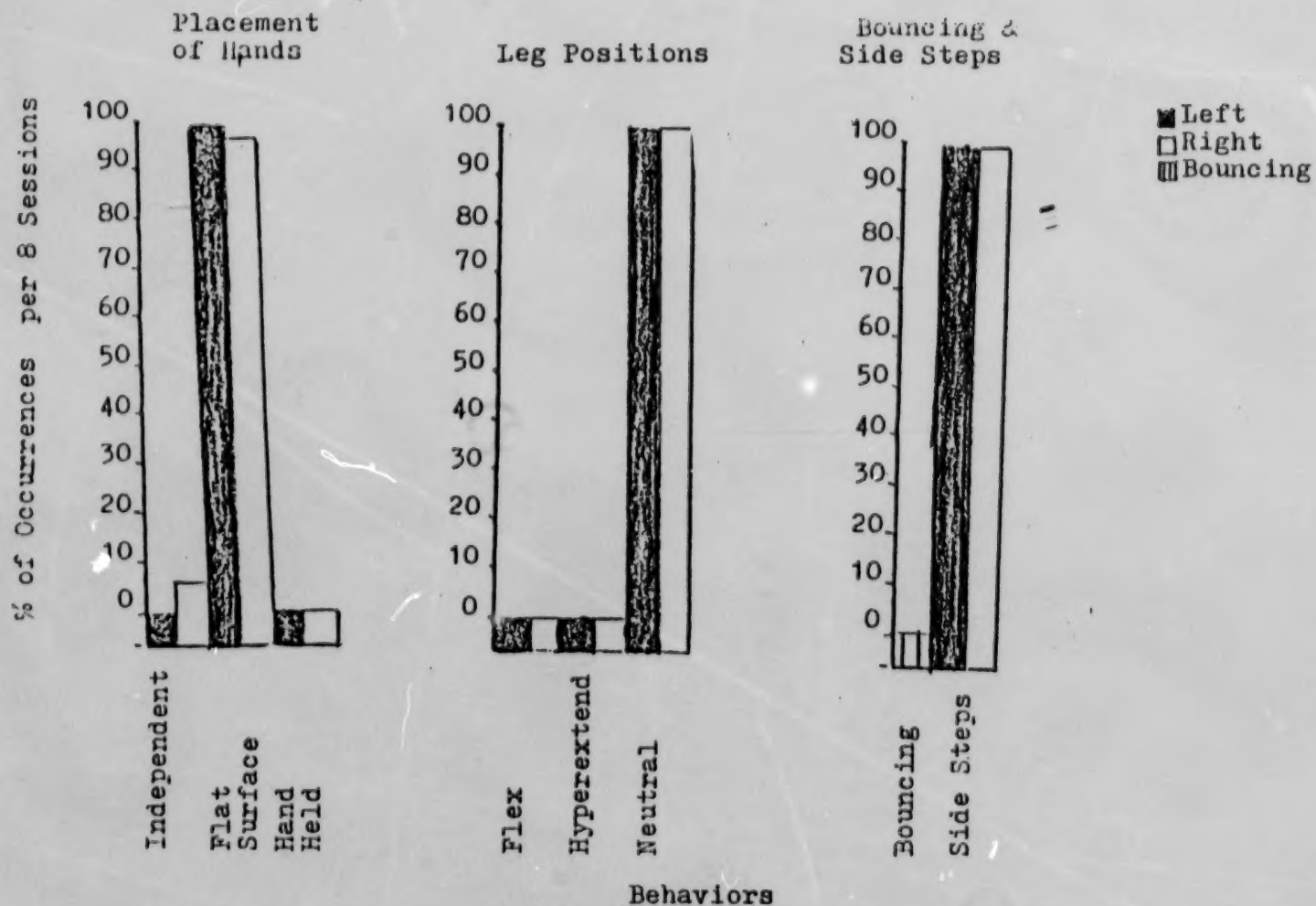


Figure 12. Percentage of occurrence of behaviors for standing and cruising for total sessions for Brad.

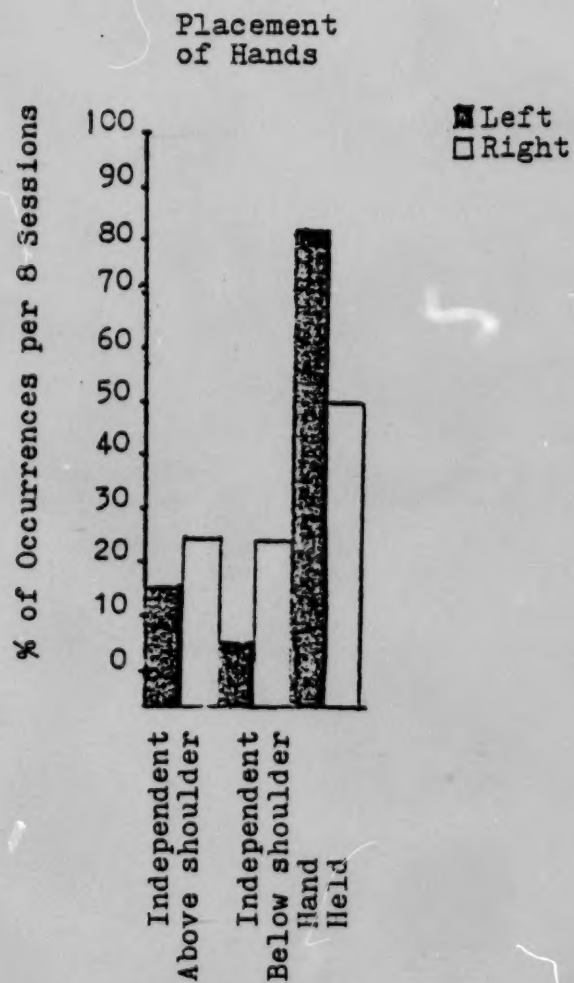


Figure 13. Percentage of occurrence of placement of hands for walking for total sessions for Brad.

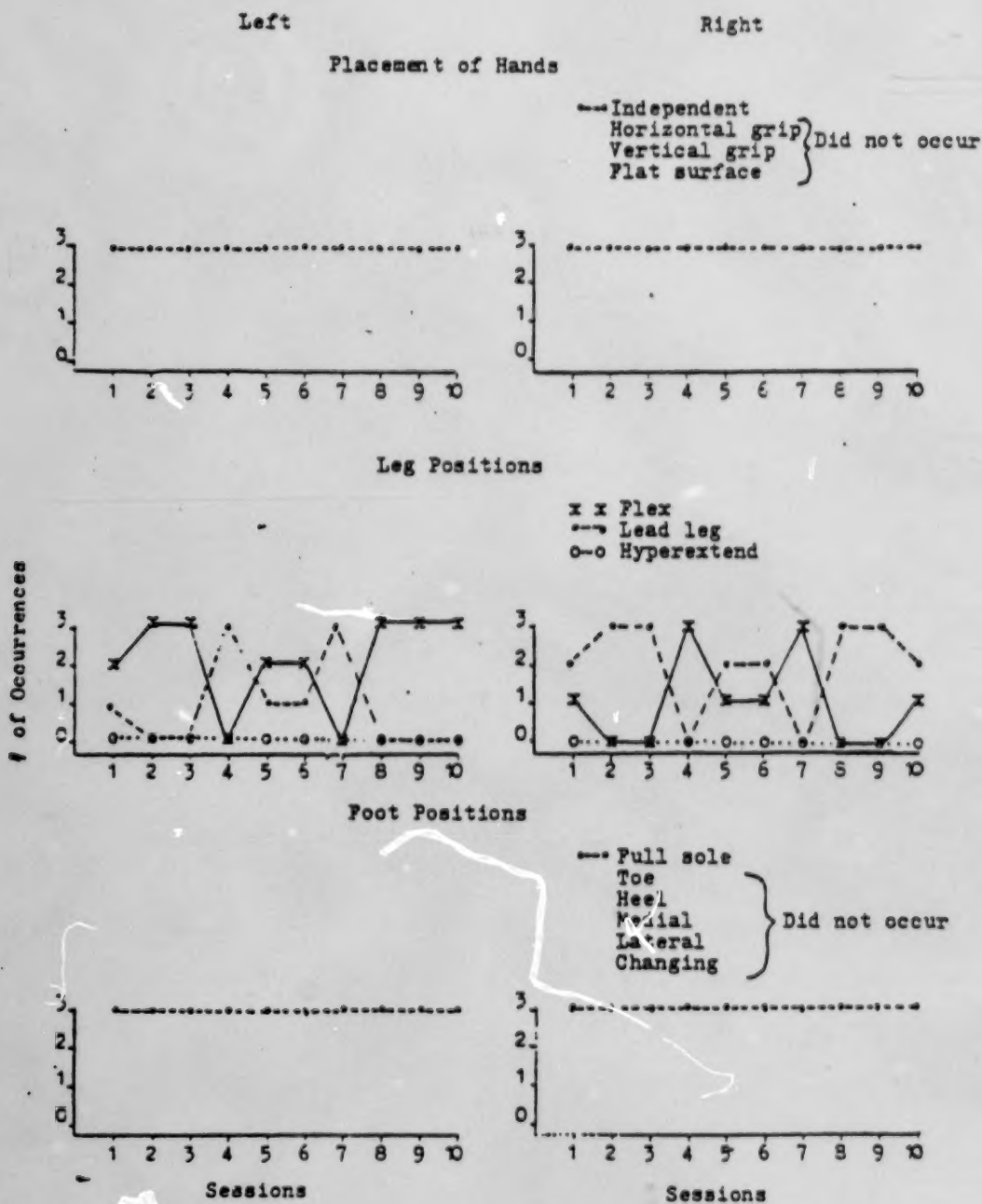


Figure 14. Occurrence of behaviors in pull to stand per session for Marie.

stance. Performance data for leg positions indicated a decreasing trend in lead leg, and an increasing trend in the flexion response. The flexion lead leg responses occurred consistently across the 10 sessions for the right leg. Marie stood repeatedly with both feet in a full sole position across all sessions.

Figure 15 presents the occurrence of behaviors, total distance, number of steps, and mean stride length for walking per session for 10 sessions. Marie held both wrists below the shoulder for independent walking for all sessions. The total distance per session ranged from 118 to 223 inches (299.72 to 566.42 cm) with a mean of 166 inches (421.64 cm). The total number of steps per session ranged from 26 to 30 steps with a mean of 29 steps. The mean stride length per session ranged from 4 to 7 inches (10.16 to 17.78 cm) with a mean stride length for 19 sessions of 5 inches (12.7 cm). There was an increasing trend for both mean stride length and the total number of steps per session.

Figure 16 presents the percentage of occurrence of behaviors for pull to stand for 10 sessions. One hundred percent of the responses for placement of hands were independent. The left leg was flexed and the right leg was the lead leg in pulling to stand for about 60% of the sessions. The full sole position occurred in 100% of the sessions for both feet.

Figure 17 presents the percentage of occurrence of behaviors for hand placement for walking. Marie held her wrist below her shoulders in independent walking for 100% of the sessions.

Subject 4 (Lu). Figure 18 presents the occurrence of behaviors in pull to stand per session for 10 sessions. Performance data for Lu's placement of hands went from three sessions of the flat surface response

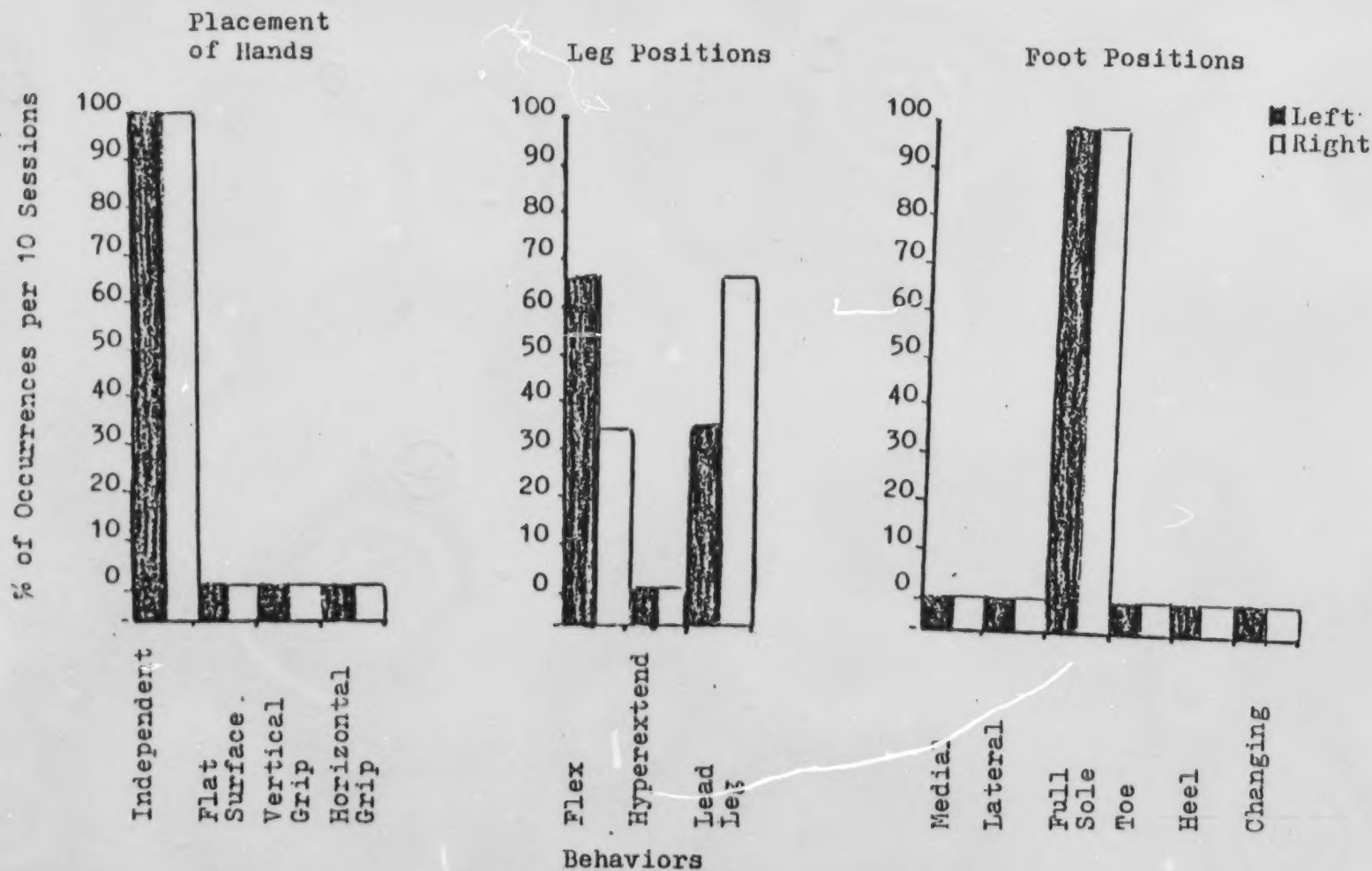


Figure 16. Percentage of occurrence of behaviors for pull to stand for total sessions for Marie.

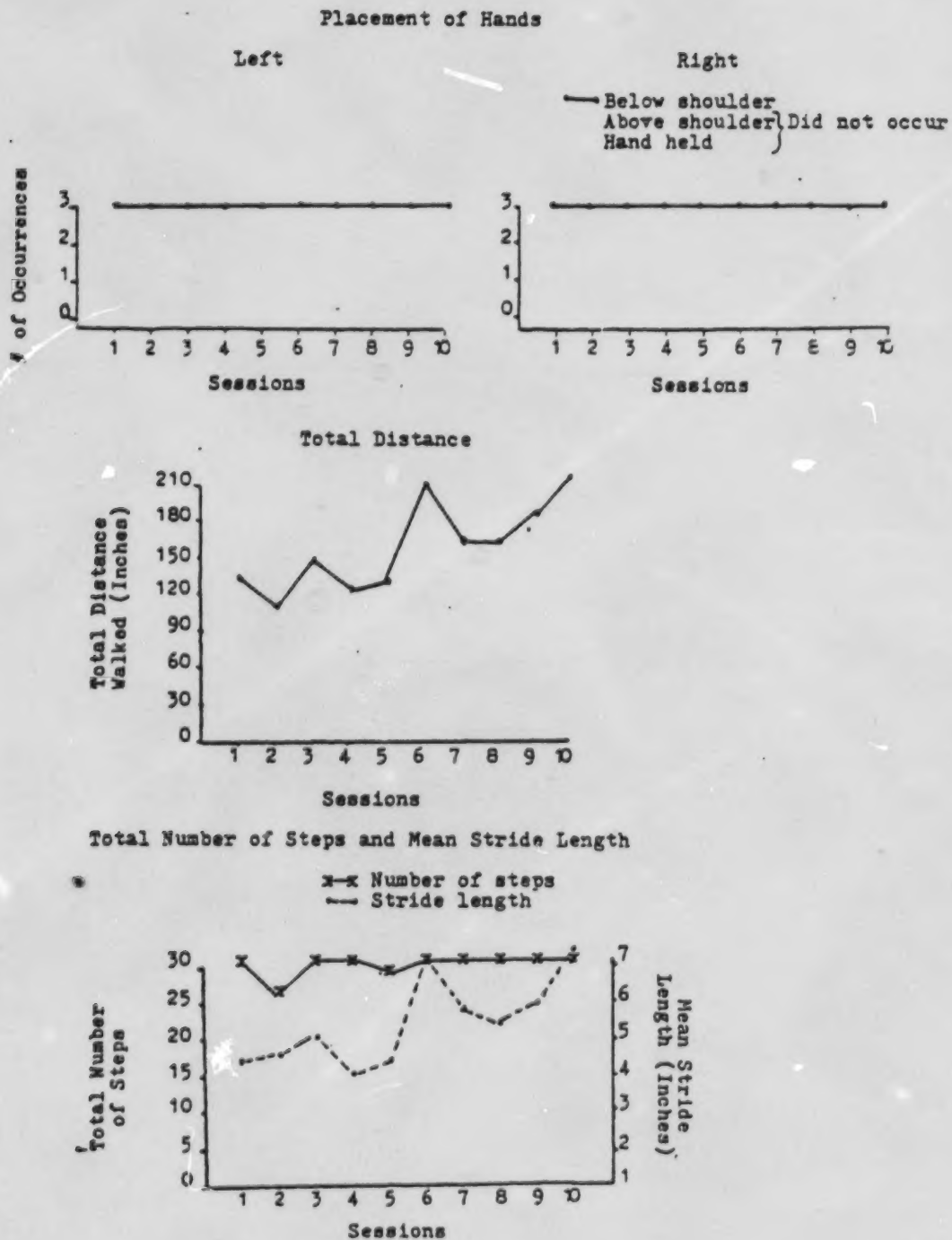


Figure 15. Occurrence of behaviors, total distance, total number of steps, meand stride lenght for walking per session for Marie.

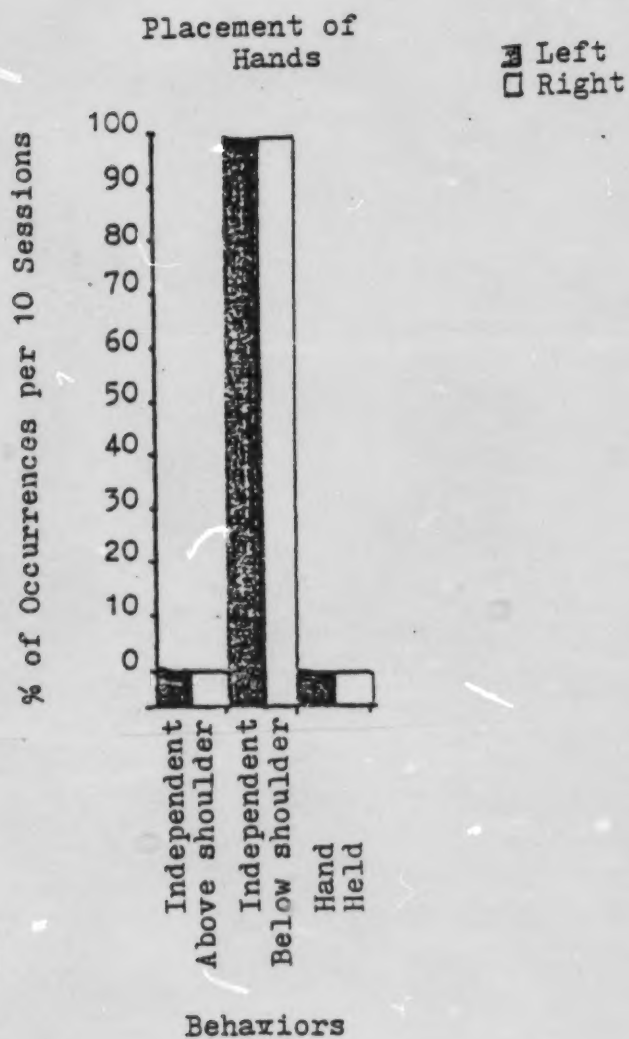


Figure 17. Percentage of occurrence of placement of hands for walking for total sessions for Marie.

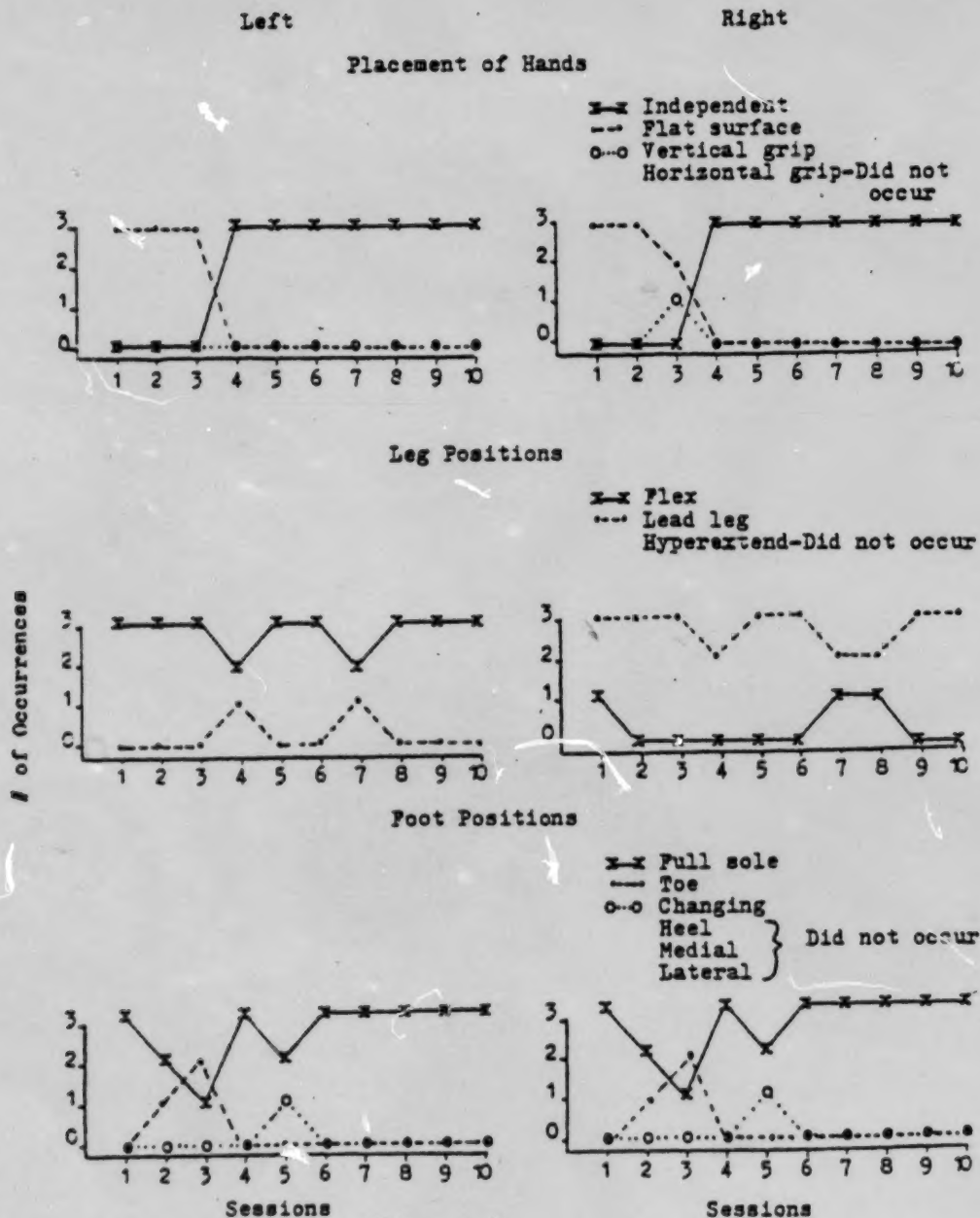


Figure 18. Occurrence of behaviors in pull to stand per session for Lu.

for the left and right hand, to independent come to stand in the last seven sessions. A fairly consistent flexion response for the left leg, and a fairly consistent lead leg response for the right occurred across sessions. There was an increasing trend in the full sole response for both feet.

Figure 19 presents the occurrence of behaviors, total distance, number of steps, mean distance, and mean stride length for walking per session for 10 sessions. Lu's left wrist response was consistently below the shoulder for independent walking. Data for the right hand indicated a decreasing trend in above the shoulder responses accompanied by an increasing trend in below the shoulder responses. The total distance walked per session ranged from 120 to 324 inches with a mean of 248 inches. The total number of steps per session was either 29 or 30 steps. The mean stride length increased across sessions and ranged from 4.3 to 10.8 inches (10.92 to 27.43 cm) with a mean of 9 inches (22.86 cm) per session.

Figure 20 presents the percentage of occurrence of behaviors for pull to stand for 10 sessions. The majority of responses in the placement of hands were independent. Across most sessions the left leg was flexed and the right leg was the lead leg in pulling to stand. The full sole foot position occurred in over 85% of all the sessions.

Figure 21 presents the percentage of occurrence of behaviors for placement of hands for walking. The major response for both hands was below the shoulder for independent walking.

Discussion

The procedures developed by Sheperd (Note 2) assessed behaviors involved in pull to stand, standing and cruising, and walking. There

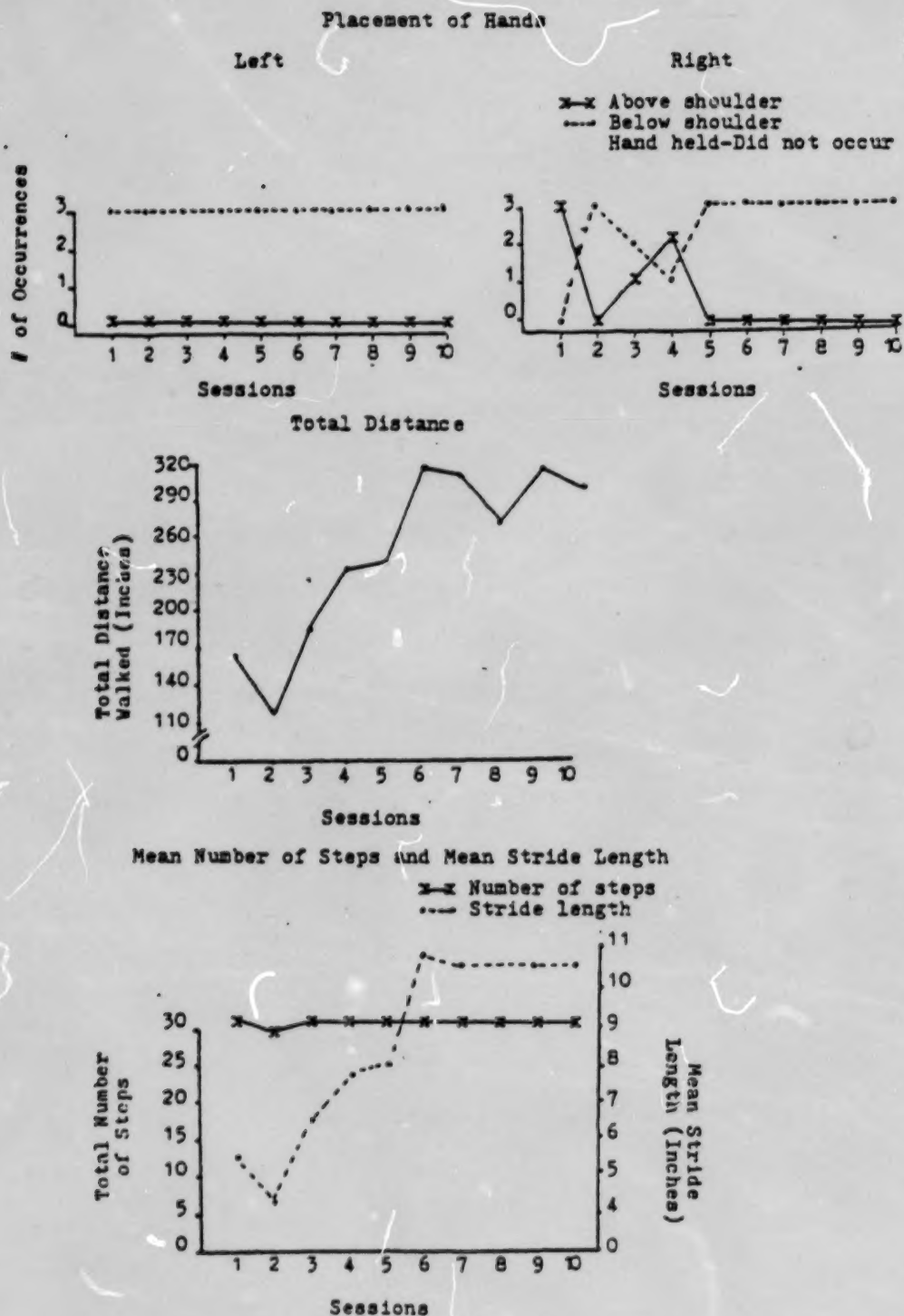


Figure 19. Occurrence of behaviors, total distance, total number of steps, mean stride length for walking per session for Lu.

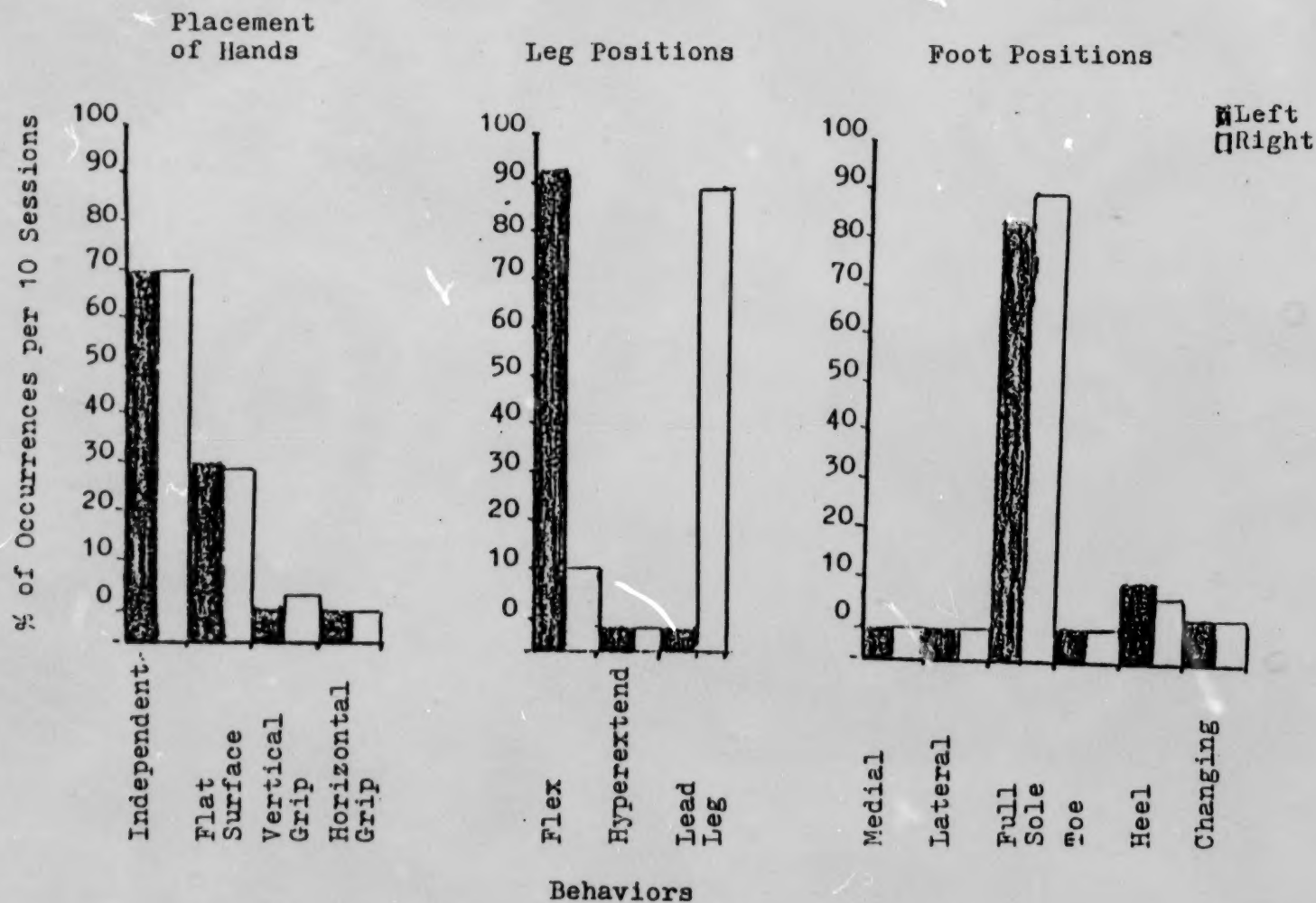


Figure 20 Percentage of occurrence of behaviors for pull to stand for total sessions for Lu.

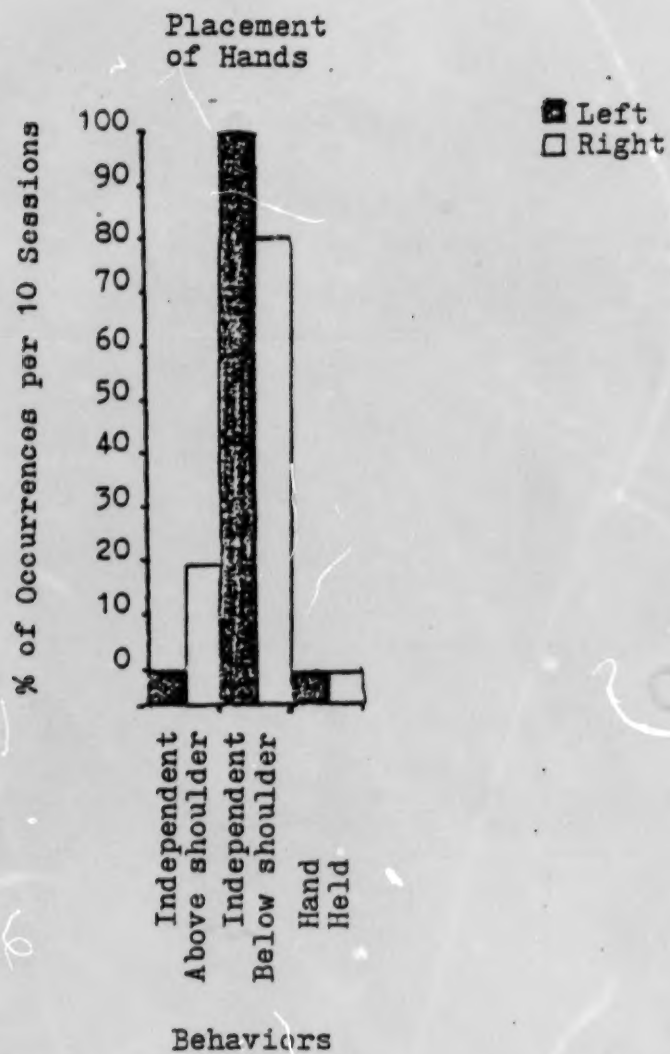


Figure 21. Percentage of occurrence of placement of hands for walking for total sessions for Lu.

were five handicapped children and one nonhandicapped child involved in the study. Data were collected across four sessions for all six children.

Changes in the original study consisted mainly of a further specification in measurement. In pull to stand, leg and foot positions were expanded and the tracing of the child's feet was eliminated. The present study replaced three pieces of equipment serving the same function. Instead of placing the child before each of the three original pieces of equipment three times for a total of nine trials, the replication study gave the child three trials of pull to stand at the chair and notation was made on which grip or surface, if any, was required for the child to achieve an upright stance.

Additions to the standing and cruising section consisted of a notation of the particular hand held (i.e., left or right) in the "hand held" measure; and a column labeled neutral leg position, for notation of normal or correct leg position. The time sampling measure of bouncing was changed to an occurrence or nonoccurrence marking for the entire observation period. The frequency count for up-and-down steps was eliminated and the measurement of sidesteps was changed to recording whether or not the child sidestepped five times to the left and/or right.

The present study expanded procedures in walking to include a notation of which hand was held (i.e., left or right) in the "one hand held" measurement. Further changes in the walking section consisted of reducing procedures; instead of four possible independent wrist positions, the present study contained only two. Additionally, the behavior descriptor of "trunk held" was removed from the type of support section.

Results from Reliability Measures

Generally, this assessment proved to be reliable in observing pull to stand, standing and cruising, and walking behaviors of handicapped and nonhandicapped children. The lowest mean reliability for one child for all behaviors in pull to stand, standing and cruising, and walking, across all sessions was 94%. The mean reliability for all children across all sessions was 99%.

Reliability for specific behavior descriptors across all children ranged from 46% to 100%. The lowest mean reliability for one behavior descriptor for one child across all sessions was 0%; the mean reliability for all behavior descriptors, for all children, across all sessions was 96%. Generally, if a reliability score was below 80% it was between 0% and 50%. For most low reliability scores, the behavior was only demonstrated by the child once or twice. Therefore if a disagreement between observers did occur it resulted in very low reliability. These behavior descriptors were "changing foot" position in pull to stand, and "flexed leg" positions in standing and cruising. Otherwise, reliability was quite good across behavior descriptors, children and sessions.

Results from Performance Data

The data presented in Figures 1 to 20 clearly indicate trends which suggest positive changes in behavioral performances. It is interesting to note the changes that did occur followed a pattern; placement of hands for Brad (Subject 2) changed from fluctuating responses in the first few sessions to a consistent "independent" come to stand in the last few sessions. Similarly, Lu (Subject 4), changed from a consistent flat surface response to a consistent "independent" come to stand. Lu also displayed a fluctuating response between the full sole and the toe

positions in standing in the beginning; in the last few sessions she consistently stood on full sole. As behavioral performance improved for Brad and Lu, decreased fluctuating responding was followed by consistent responding. In standing, Ruth (Subject 1) kept both hands on a flat surface, but across time she began to display an independent hand position occasionally. Again, change was noted when Ruth (Subject 1) needed both hands held while walking, after five weeks she fluctuated between hand held and independent below the shoulder placement for one hand. Lu (Subject 4), held her left wrist below the shoulder throughout, but only in the last few sessions did her right wrist stop fluctuating above and below the shoulder. As these behavioral performances improved for Ruth and Lu, consistent assisted responses were followed by fluctuating independent responses.

Decreasing trends in responses were noted in walking distance and number of steps. Ruth (Subject 1) and Brad (Subject 2) increased walking distance until a decrease was noted in the last session. These patterns of responding may be the result of Brad and Ruth's attempts to walk independently. Brad was experimenting with a few independent steps occasionally, rather than walking several steps with assistance. Ruth was beginning to walk with only one hand held, instead of two, and may have required a smaller stride length to gain stability.

The recording of the performance of the left and right hand, leg, and/or foot provided information regarding the child's motor development and/or impairment of specific body parts or muscle groups. Evidence of this is reflected in the performance data for Brad (Subject 2). He consistently used his right leg to lead the half-kneel in pulling to stand. Brad's left foot position fluctuated between toe, full sole, and

changing; his right fluctuated between full sole and changing. These data show that the assessment was sensitive enough to detect differences in the behavioral performance of various muscle groups.

Recommendations for Further Research

Future research should include observation of the presence of reciprocal gait and observation of the width or type of stance used in standing and walking. Consideration should also be given to the duration of independent stand immediately after the child comes to stand independently, and to the duration of independent stand after the child has been placed in a standing position or after the child has pulled to stand. Additionally, observations of foot position in cruising and walking may provide further information of the sequence of the development of walking.

Although behavior descriptors of leg positions of hyperextension, and foot positions of medial, lateral, and heel were not observed under the formal observations of this study, the author recommends that these descriptors remain in future research. These behaviors should be researched further through assessment of additional children, since the author did note these behaviors in informal observations outside the study.

Additional longitudinal research employing these procedures with both handicapped and nonhandicapped children is necessary in order to establish an accurate developmental sequence of these skills. Further research is needed to determine whether one skill is influenced by the acquisition of another. The development of a sensitive measurement tool will enhance the possibilities for early identification of handicapping conditions and may then be utilized to assess the effects of intervention programs.

APPENDIX A

Reliability Scores for Pulling to Stand for Ruth

Sessions	Reliability per session			Row Mean
	Placement of hands	Leg position	Foot position	Reliability
1	83	100	100	94
2	83	100	100	94
3	100	66	100	88
4	100	100	83	94
5	100	100	83	94
6	100	100	83	94
7	100	100	100	100
8	83	100	83	89
9	83	100	100	94
10	100	100	83	94
Column mean reliability	93	97	92	Grand mean reliability 94

APPENDIX B

Reliability Scores for Standing and Cruising for Ruth

Sessions	Reliability per session					Row Mean
	Hands	Legs	Bouncing	Side steps	Duration	Reliability
1	100	100	100	100	100	100
2	100	100	100	100	100	100
3	83	100	100	100	100	97
4	100	100	100	100	100	100
5	100	100	100	100	100	100
6	100	100	100	100	100	100
7	100	100	100	100	100	100
8	100	83	100	100	100	97
9	100	100	100	100	100	100
10	100	100	100	100	100	100
Column mean reliability	98	98	100	100	100	Grand mean reliability 99

APPENDIX C

Reliability Scores for Walking for Ruch

Sessions	Reliability per session				Row Mean
	Hands	# of steps	Distance	Duration	Reliability
1	100	100	100	100	100
2	100	66	100	100	92
3	100	100	100	100	100
4	100	100	100	100	100
5	100	100	100	100	100
6	100	100	100	100	100
7	100	100	100	100	100
8	100	100	100	100	100
9	66	100	100	100	92
10	100	100	100	100	100
Column mean reliability	97	97	100	100	Grand mean reliability 98

APPENDIX D

Reliability Scores for Pulling to Stand for Brad

Sessions	Reliability per session			Row Mean Reliability
	Placement of hands	Leg position	Foot position	
1	100	100	67	89
2	100	100	100	100
3	83	100	100	94
4	100	100	83	94
5	100	100	67	89
6	100	100	100	100
7	100	100	67	89
8	100	100	100	100
Column mean reliability	98	100	86	Grand mean reliability 94

APPENDIX E

Reliability Scores for Standing and Cruising for Brad

Sessions	Reliability per session					Row Mean
	Hands	Legs	Bouncing	Side steps	Duration	Reliability
1	100	83	100	100	100	97
2	100	100	100	100	100	100
3	100	100	100	100	100	100
4	100	100	100	100	100	100
5	100	100	100	100	100	100
6	100	100	100	100	100	100
7	100	100	100	100	100	100
8	100	100	100	100	100	100
Column mean reliability	100	98	100	100	100	Grand mean reliability 100

APPENDIX F

Reliability Scores for Walking for Brad

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Sessions	Reliability per session				Row Mean
	Hands	# of steps	Distance	Duration	Reliability
1	100	100	100	100	100
2	100	100	100	100	100
3	100	100	100	100	100
4	100	100	100	100	100
5	83	100	100	100	96
6	100	100	100	100	100
7	100	100	100	100	100
8	100	100	100	100	100
Column mean reliability	98	100	100	100	Grand mean reliability 100

APPENDIX G

Reliability Scores for Pulling to Stand for Lu

Sessions	Reliability per session			Row Mean
	Placement of hands	Leg position	Foot position	Reliability
1	100	100	100	100
2	100	100	100	100
3	100	100	100	100
4	100	100	100	100
5	100	100	67	89
6	100	100	100	100
7	100	100	100	100
8	100	83	100	94
9	100	100	100	100
10	100	100	100	100
Column mean reliability	100	98	97	Grand mean reliability 94

APPENDIX H

Reliability Scores for Standing and Cruising for Lu

Sessions	Reliability per session					Row Mean
	Hands	Legs	Bouncing	Side steps	Duration	Reliability
1	83	100	100	100	100	97
2	100	100	100	100	100	100
Column mean reliability	92	100	100	100	100	Grand mean reliability 99

APPENDIX I

Reliability Scores for Walking for Lu

Sessions	Reliability per session				Row Mean
	Hands	# of steps	Distance	Duration	Reliability
1	100	100	100	100	100
2	100	100	100	100	100
3	83	100	100	100	96
4	100	100	100	100	100
5	100	100	100	100	100
6	100	100	100	100	100
7	100	100	100	100	100
8	100	100	100	100	100
9	100	100	100	100	100
10	100	100	100	100	100
Column mean reliability	98	100	100	100	Grand mean reliability 100

APPENDIX J

Reliability Scores for Pulling to Stand for Marie

Sessions	Reliability per session			Row Mean
	Placement of hands	Leg position	Foot position	Reliability
1	100	100	100	100
2	100	100	83	94
3	100	100	100	100
4	100	83	100	94
5	100	100	100	100
6	100	100	100	100
7	100	100	100	100
8	100	100	100	100
9	100	100	100	100
10	100	100	100	100
Column mean reliability	100	98	98	Grand mean reliability 99

APPENDIX K

Reliability Scores for Standing and Cruising for Marie

Sessions	Reliability per session					Row Mean
	Hands	Legs	Bouncing	Side steps	Duration	Reliability
1	100	100	100	100	100	100
2	100	100	100	100	100	100
Column mean reliability	100	100	100	100	100	Grand mean reliability 100

APPENDIX L

Reliability Scores for Walking for Marie

Sessions	Reliability per session				Row Mean
	Hands	# of steps	Distance	Duration	Reliability
1	100	100	100	100	100
2	100	100	100	100	100
3	100	100	100	100	100
4	100	100	100	100	100
5	100	100	100	100	100
6	100	100	100	100	100
7	100	100	100	100	100
8	100	100	100	100	100
9	100	100	100	100	100
10	100	100	100	100	100
Column mean reliability	100	100	100	100	Grand mean reliability 100

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STABILITY
Procedures for Measuring
Standing and Sitting

by

Eileen Luddy,¹ Donna Lehr, and Mary Jo Noonan

¹The procedures reported in this study were taken, in part, from a master's thesis conducted by Eileen Luddy that was submitted to the Department of Special Education at the University of Kansas in August, 1980.

Selecting the Target Behaviors

Pulling to stand with and without support and sitting with and without support were selected because these are considered requisite skills to total independent locomotion via walking. These behaviors incorporate the use of the four extremities and the trunk. An assessment that quantitatively measures these skills could aid in furthering the education of the severely multiply handicapped population. Such an assessment procedure would provide a teacher with accurate information on the child's current abilities in these tasks, as well as provide a sensitive tool for measuring the child's progress.

Standing and sitting were subdivided into six specific areas after reviewing available standardized and nonstandardized instruments for assessing motor development. These include: 1) standing from a chair using a table for support, 2) standing from a chair without using a table for support, 3) sitting in a chair from standing at a table, 4) sitting in a chair without use of a table for support, 5) standing from the floor without support, and 6) sitting from standing on the floor without support.

Developing the Measurement and Observation Procedures

The six areas of standing and sitting are discussed according to the following headings: a) Specifications of the Behavior, b) Space and Materials Needed, c) Observational Setting, d) Conditions of the Assessment, e) Providing Cues to the Child, f) Assessment Procedures, and g) Specifications for Taking Reliability.

The section entitled Specifications of the Behavior includes a brief analysis of each skill. Space and Materials Needed delineates the

materials that the examiner needs in order to complete the assessment, as well as the physical arrangements of the materials. Observational Setting describes the possible locations for administering the assessment. Conditions of the Assessment include the positioning of the subject and the observers. Providing Cues to the Child specifies what is needed to begin the trial and instructions for providing the prompts. Assessment Procedures include instructions for conducting the assessment and the types of data the examiner and observer record (coding, grid marking, and response time). Specifications for Recording Reliability describes how to record reliability for each of the areas of standing and sitting. The formula for determining the agreement among observers is included.

Measuring Stand from a Chair Using a Table

Specification of Behavior

Standing from a chair using a table is defined here as when the child obtains support for the table using his hands in order to obtain an upright posture. Behaviors in this task include placing the hands on the table, positioning the feet on the floor, and raising the buttocks off of the seat by flexing and then extending the legs and the arms. The measures taken consist of coding whether or not the specified behaviors involved in the task were observed, such as positioning and location of hands and feet on the grid, knee positioning, and the response time.

Space and Materials Required

The space needed to administer the assessment should be an area large enough to accommodate the floor grid (approximately 36" x 36"), a table, chair, the subject, the examiner, and the observer.

While the child is sitting in a chair at the table, his hands should be able to rest on top of the table with slight flexion of the arms, and the height of the table should be adjusted accordingly. The seat of each child's chair should be the same height as the back of the child's knee.

The two grids required for measuring the location of the hands and feet are measured into three inch squares. The grid has six squares in each row, with six rows, the squares numbering 1-36 (see Figure 1). Although plexiglass is used for the grid in this study, other easily obtainable materials can be used. For example, a poster board or plastic sheet with the squares measured and marked directly on it can be used. Another alternative would be to use tape to block off squares on the table top and the floor.

Favorite toys, objects or edibles can be used to motivate the child to stand. The teacher can select these items, or parents can suggest items that the child prefers.

Two stop watches are needed, one for each observer. Data Sheet #1 (Figure 2), two clip boards, pencils, and a tape measure concludes the items required for measuring this skill.

Observational Setting

Observations should take place in a setting where the child can demonstrate an ability to stand from a chair using a table for support. These structured settings are in the classroom, the child's home, or in any school setting given the availability of appropriately sized furniture.

Conditions of the Assessment

Initial positioning. The child should be placed in a chair with the front legs of the chair in the third row of the grid. The knees

31	32	33	34	35	36
25	26	27	28	29	30
19	20	21	22	23	24
13	14	15	16	17	18
7	8	9	10	11	12
1	2	3	4	5	6

HANDS

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36

FEET

Figure 1. Grid for Placement of Hands and Feet.

Stand from Chair with Table

Student _____ Examiner _____

Date _____ Observer _____

+ - correct

A+ - Abnormal tone/correct

0 - incorrect

A- - Abnormal tone/incorrect

		1	2	3	4	R
Hands on table - Hands flat on table, weight bearing on palms	Right					
	Left					
Feet on floor - flat, legs extend while coming to stand. Bear weight on balls of feet and heels.	Right					
	Left					
Knees flex to extension simultaneous movement.	Right					
	Left					
Trunk - Subject brings trunk into upright position by extending arms and legs						
Time - Number of seconds from placement of at least one hand on table to trunk erect for 2" - limit of 30" after trial begins						

CODE:

X - flat foot // - side of foot = - on toes X - hands placed

HANDS	1	2	3	4
	31 32 33 34 35 36	31 32 33 34 35 36	31 32 33 34 35 36	31 32 33 34 35 36
	25 26 27 28 29 30	25 26 27 28 29 30	25 26 27 28 29 30	25 26 27 28 29 30
	19 20 21 22 23 24	19 20 21 22 23 24	19 20 21 22 23 24	19 20 21 22 23 24
	13 14 15 16 17 18	13 14 15 16 17 18	13 14 15 16 17 18	13 14 15 16 17 18
	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12
FEET	1	2	3	4
	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12
	13 14 15 16 17 18	13 14 15 16 17 18	13 14 15 16 17 18	13 14 15 16 17 18
	19 20 21 22 23 24	19 20 21 22 23 24	19 20 21 22 23 24	19 20 21 22 23 24
	25 26 27 28 29 30	25 26 27 28 29 30	25 26 27 28 29 30	25 26 27 28 29 30
FEET	1	2	3	4
	31 32 33 34 35 36	31 32 33 34 35 36	31 32 33 34 35 36	31 32 33 34 35 36
	25 26 27 28 29 30	25 26 27 28 29 30	25 26 27 28 29 30	25 26 27 28 29 30
	19 20 21 22 23 24	19 20 21 22 23 24	19 20 21 22 23 24	19 20 21 22 23 24
	13 14 15 16 17 18	13 14 15 16 17 18	13 14 15 16 17 18	13 14 15 16 17 18
	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12

Figure 2. Data Sheet #1.

should be perpendicular to the edge of the table, with the feet flat on the floor grid, and the hands resting on the lap.

Position of the observers. After positioning the child, the examiner moves approximately one foot away from the subject, slightly to the side, to allow for front viewing, while the observer is similarly positioned on the opposite side. See Figure 3 for an illustration of this arrangement.

Providing Cues to the Child

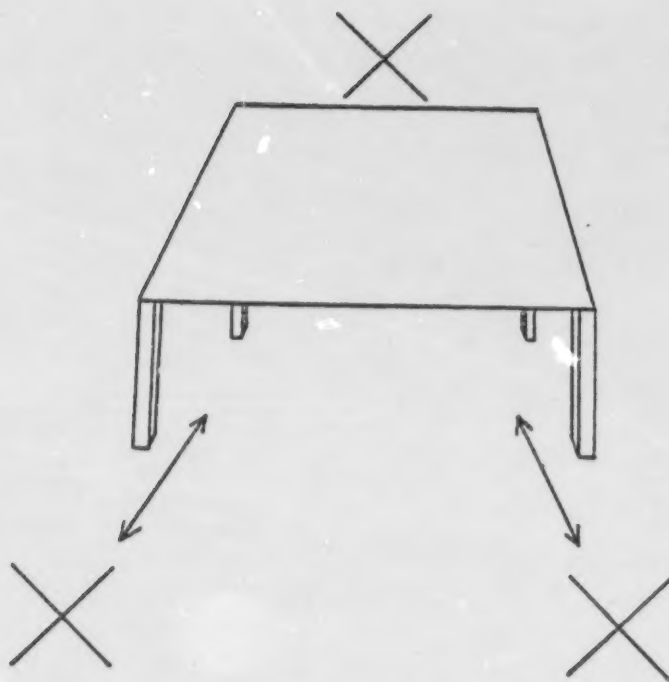
There are two cues used to occasion a response from the child.

Verbal cue. The examiner initiates the trial with the cue "stand up," at the same time activating the stop watch. This cue can be repeated if after 30 seconds the child has not begun to stand.

Physical prompt. After the second verbal cue and 30 seconds has elapsed, the examiner can prompt the subject by slightly touching him from the back either under the arms or at the hips. It is important that the examiner avoid contact with the child's hands and legs, as this would interfere with the trial.

Measuring Stand from a Chair Using a Table

There are three types of data collected by the examiner and observer using Data Sheet #1 (see Figure 2). A code of correct (+) is recorded if the child demonstrates placement of hands on the table, puts his feet flat on the floor, flexes his knees and then extends them, and brings his trunk upright once his legs are extended. Incorrect (o) is recorded if the child does not demonstrate any one of these behaviors. Abnormal tone (a) is recorded if the child is unable to complete the task due to involuntary muscle contractures. The location of the hands and feet on the grid are recorded using the code of flat on the floor (1), on the sides (2), or on the toes (3) for the feet, and an X for indicating the hand locations. The response time is recorded last.



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Figure 3. Position of Observers.

placement of the child's hand or foot are located in exactly the same square, b) any portion of the X indicating placement of the child's hand or foot recorded by the observer that appeared in the same square as that of the examiner. Observers were considered to disagree if the recorded code for the position shared no common location on the grid.

Measuring Stand from a Chair Without Use of a Table

Specification of Behavior

The definition of standing from a chair without use of a table is broadly analyzed to include any variation in hand placement (other than on the table). These are 1) on arms of the chair, 2) on the edge of the chair, 3) on the lap, or 4) left on the sides or in front of the trunk. Other behaviors included in this task are raising the buttocks off of the seat by extending the legs, feet flat on the floor, and "righting" the trunk once an upright position is attained. The measures taken include recording the code corresponding to location and position of the feet, positioning of the hands, and whether or not the knees, trunk, and feet demonstrated correct (+), incorrect (o), or abnormal tone (a). The response time is also recorded.

Space and Materials Required

The space needed for this assessment includes an area large enough to accommodate the floor grid, a chair, the subject, the examiner, and the observer.

The size of the chair is determined by measuring from the child's heel to mid-knee. The same floor grid used for measuring the other areas of standing can be used for this one (three inch squares numbered 1-36).

Assessment Procedure

Step 1. Place the child in the chair with front legs of the chair in row three of the grid, feet flat on the floor, knees perpendicular to the edge of the table.

Step 2. Give the verbal cue to initiate the trial.

Step 3. Begin the stop watch.

Step 4. Stop the trial when the child is standing for two seconds.

Step 5. Record the location of the hands and feet on the grid.

Step 6. Record the behaviors observed.

Step 7. Record the response time.

Specifications for Taking Reliability

The number of agreements and number of disagreements are totaled between the two observers for the various positions demonstrated by the child and are totaled for each session across the trials. The number of agreements is divided by the number of agreements plus disagreements, and then multiplied by 100 to obtain reliability percentages for each session. The formula is as follows:

$$R = \frac{\text{No. of agreements}}{\text{No. of agreements} + \text{No. of disagreements}} \times 100.$$

The mean reliability scores across all sessions for each position is determined by adding together all the reliability scores from each session and dividing by the total number of sessions. The response time reliability is calculated by dividing the larger time into the smaller time and multiplying that number by 100.

The reliability scores for the hands and feet grids are calculated according to the following criteria: Grids completed by the observer and examiner were compared for agreements and disagreements. The observers are in agreement if the following conditions are met: a) X's indicating

Stimulating visual, auditory and tactile toys can be used to occasion the desired response. The reinforcers used however, should not be given to the child until the trial is complete, as this would interfere with the variations in hand placement. Two stop watches, one for each observer, Data Sheet #2 (see Figure 4), two clip boards, pencils, and a tape measure are also needed for assessing this skill.

Observational Setting

The assessment can take place most anywhere the child can demonstrate the ability to stand from a chair without the support of a table. This can be in the child's home, in the classroom, or any structured setting in the school where appropriately sized furniture is available.

Conditions of the Assessment

Initial positioning. The child should be placed in a chair on the floor grid with the front legs of the chair in the third row of the grid. Feet should be flat on the floor, with hands resting on the lap.

Position of the observers. After positioning the child, the examiner should move approximately one foot away. The examiner should be slightly in front of the subject on the opposite sides as illustrated in Figure 6.

Providing Cues to the Child

There are two types of cues given to obtain a response from the child.

Verbal cue. The examiner initiates the trial with the verbal cue "stand up," at the same time beginning the stop watch. If after 30 seconds, the child has not initiated a response, a second verbal cue is given.

Stand from Chair Without Table

Subject _____ Examiner _____

Date _____ Observer _____

CODE: correct (+)
 incorrect (0)
 abnormal tone (ab)

		1	2	3	4	R
Hands -(1) Placed on arm of chair (2) edge of chair (3) lap (4) not used	Right					
	Left					
Feet - Remain Flat on floor slightly apart.	Right					
	Left					
Knees - extend while attempting to stand	Right					
	Left					
Buttocks - Raised off chair while legs are extending						
Trunk - "Rights" within 2 seconds of standing						
Time - Begins with cue "Standup" ends 2 seconds after standing						

CODE:

X - flat foot // - side of foot == - on toes X - hands placed

	1					
	1	2	3	4	5	6
	7	8	9	10	11	12
13	14	15	16	17	18	
19	20	21	22	23	24	
25	26	27	28	29	30	
31	32	33	34	35	36	

	2					
	1	2	3	4	5	6
	7	8	9	10	11	12
13	14	15	16	17	18	
19	20	21	22	23	24	
25	26	27	28	29	30	
31	32	33	34	35	36	

	3					
	1	2	3	4	5	6
	7	8	9	10	11	12
13	14	15	16	17	18	
19	20	21	22	23	24	
25	26	27	28	29	30	
31	32	33	34	35	36	

	4					
	1	2	3	4	5	6
	7	8	9	10	11	12
13	14	15	16	17	18	
19	20	21	22	23	24	
25	26	27	28	29	30	
31	32	33	34	35	36	

Figure 4. Data Sheet #2.

Physical prompt. After the second cue and 30 seconds, if the child has not yet responded, the examiner can prompt the child to stand slightly touching him from the back either under his arms or at the hips. Do not contact the subject's hands or legs, to avoid influencing the placement of the hands and feet.

Measuring Stand from a Chair Without Use of a Table

The examiner and observer record three types of data. The code for hand placement is numbered one through four. When the child places his hands on the arms of the chair, the code (1) is recorded. Hands placed on the edge of the chair are represented by (2). If the child places his hands on his lap while attempting to stand, (3) is recorded, and finally, if the child does not use his hands to stand up, code (4) is recorded. A code of correct (+) is recorded if the child demonstrates the following behaviors: raises the buttocks off of the seat while legs are extending, extends at his knees while standing up, and feet remain flat on the floor during the demonstration of this task. If these behaviors are not demonstrated, the data sheet is coded with an incorrect (o) response, or abnormal tone (a), denoting that the child did not perform the task due to abnormal muscle tone interference. The grid is coded when the following observations are made; (X) implies feet are flat on the floor while the child is standing up, (=) indicates the child stands up on his toes when the grid observation is made, or (//) indicates the child is standing on the side of his foot. The response time is recorded last.

Assessment Procedure

Step 1. Place the child in the chair with the front legs of the chair in row three of the floor grid, feet flat on the floor, hands resting on the lap.

Step 2. Examiner initiates the trial by giving the verbal cue "stand up."

Step 3. Begin the stop watch.

Step 4. Stop the trial when the child is standing up for 2 seconds.

Step 5. Record the location of the feet on the grid.

Step 6. Record the behaviors observed during the trial.

Step 7. Record the response time.

Specifications for Taking Reliability

Reliability scores for the positions observed are recorded by comparing the number of agreements and disagreements between the observer and the examiner for each of the behaviors demonstrated by the subject using the following formula:

$$R = \frac{\text{No. of agreements}}{\text{No. of agreements} + \text{No. of disagreements}} \times 100.$$

The reliability scores for the time response in each session is calculated by dividing the smaller response time into the larger response time and then multiplying that number by 100.

Reliability scores for the hand and feet grid are calculated according to the following criteria: Grids completed by the observer and examiner were compared for agreements and disagreements. The observers are considered to be in agreement when the following conditions are met: a) X's indicating placement of the child's foot were located in exactly the same square, b) any portion of the X indicating placement of the child's foot recorded by the observer that appeared in the same square as that

of the examiner. Observers were considered to disagree if the recorded code for the position shared no common location on the grid.

Measuring Sit in Chair From Stand Using a Table

Specification of Behavior

Sitting in a chair from the standing position at a table is briefly defined as a task beginning with the child standing in an upright position with hands placed on the table for support. The feet are flat on the floor, slightly apart, while the knees flex to lower the buttocks to the seat. When the buttocks contact the seat, the hands leave the table and the subject "rights" the trunk (observable by the back meeting the back of the chair). Measures taken include a code of correct (+), incorrect (o), or abnormal tone (a), indicating whether or not the specified behaviors (positions of the knees, arms, hands, feet, and trunk) were observed. The response time is also recorded.

Space and Materials Required

The dimensions required for measuring this skill include an area to accommodate a table, chair, the subject, the examiner, and the observer. The height of the table should allow the child's hands to rest on top with a slight flexion of the arms when the child is sitting in the chair. The seat of each chair should be the same height from the floor as the back of the subject's knees. It could be an inch or two lower, but not higher.

Additional materials include attractive items to motivate the child to respond, two stop watches (one for each observer), Data Sheet #3 (Figure 5), two clip boards, pencils, and a tape measure.

Sit in Chair from Stand at Table

Student _____ Examiner _____

Date _____ Observer _____

CODE: Correct (+)
 incorrect (0)
 abnormal tone (a)

Trials

		1	2	3	4	R
<u>Knees</u> - flex to lower buttocks to seat in chair	Right					
	Left					
<u>Arms</u> - flex as buttocks is lowering to chair	Right					
	Left					
<u>Hands</u> - remain flat on table until buttocks arrives in seat	Right					
	Left					
<u>Feet</u> - remain flat on floor until buttocks arrives in seat.						
<u>Trunk</u> - "rights" when hands leave table						
<u>Time</u> - begin with verbal cue "Sit down", and ends seconds after sitting						

Figure 5. Data Sheet #3.

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Observational Setting

The assessment can be conducted where the child can demonstrate an ability to sit in a chair from standing at a table. This can include a classroom, the child's home, or any structured setting given the availability of appropriately sized furniture.

Conditions of the Assessment

Initial positioning. The child should be placed in a standing position at the table (trunk approximately four inches away from the edge), hands resting on top of the table with a very slight flexion at the elbows.

Position of the observers. After positioning the child, the examiner should move approximately one foot away, slightly to the front of the subject. The observer should be on the opposite side in a similar position.

Providing Cues to the Child

There are two cues used to elicit the response from the child:

Verbal cue. The trial begins when the examiner says "sit down." This can be repeated if after 30 seconds the subject is still standing.

Physical prompt. After the second cue is given, and 30 seconds has elapsed, the examiner can prompt the child from behind by touching the hips and applying slight pressure to generate flexion (Figure 6).

Measuring Sit in Chair from Stand Using a Table

There are two types of data recorded by the examiner and observer. A code of correct (+) is recorded if the child demonstrates knee flexion when the buttocks are lowering to the seat, the arms extend, hands remain on the table, the feet remain flat on the floor, and the trunk



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Figure 6. Placement of Examiner's Hands for Hip Flexion.

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"rights" in the chair when the hands leave the table. Incorrect (o) is recorded if the child does not demonstrate these behaviors. If the child has abnormal tone, and is unable to complete the skill because of this, a code for abnormal tone (a) is used. The response time is recorded last.

Assessment Procedure

Step 1. Place the child in a standing position at the table.

Step 2. The examiner initiates the trial by giving the verbal cue "sit down."

Step 3. Begin the stop watch.

Step 4. Stop the trial when the child's buttocks are in the seat for two seconds.

Step 5. Record the behaviors observed.

Step 6. Record the response time.

Specifications for Taking Reliability

Reliability scores are determined by comparing the number of agreements and disagreements between the observer and examiner for each of the behaviors demonstrated by the subject using the following formula:

$$R = \frac{\text{No. of agreements}}{\text{No. of agreements} + \text{No. of disagreements}} \times 100.$$

The reliability scores for time response in each session are calculated by dividing the smaller response time into the larger response time and then multiplying that number by 100.

Measuring Sit in Chair from Stand Without Table

Specifications of Behavior

Sitting in a chair from independent standing is defined as a task beginning with the child in an upright position with trunk erect, feet

flat on the floor slightly apart, and hands resting at the sides. Flexing the legs at the knees to lower the buttocks to the seat, the child may place his hands on the arms or the edge of the chair, or not use his hands at all. When the buttocks reach the seat, the child "rights" the trunk and assumes a sitting position. Measures taken include the hand positioning that the child demonstrates (corresponding to the code), and a code to indicate correct (+), incorrect (o), or abnormal tone (a) for the knees, feet, buttocks, and trunk positions. The duration of the response is also recorded.

Space and Materials Required

An area to accommodate a chair, subject, examiner and observer is required. the seat of the chair should be the same height as the child's knees are from the floor.

Auditory, tactile, or visual stimuli can be used to motivate the child to perform the task. Additional materials needed are two stop watches, Data Sheet #4 (Figure 7), two clip boards, pencils, and a tape measure.

Observational Setting

Sitting in a chair without a table support can be demonstrated by the child in any setting where the appropriately sized chair can be obtained. This can be in the child's home, in the classroom, or in any school setting.

Conditions of the Assessment

Initial positioning. Place the child in an upright position with feet flat on the floor, a few inches apart. Hands should be resting at the sides, and the seat of the chair should be approximately two inches from the back of the subject's knees.

Sit In Chair from Stand Without Table

Student _____ Examiner _____

Date _____ Observer _____

CODE: Correct (+)
 incorrect (0)
 abnormal tone (a)

Directions - Place the corresponding
 code in the box.

		Trial				
		1	2	3	4	R
Hands - (1) on arms of chair (2) on edge of chair (3) on lap (4) Not Used	Right					
	Left					
Buttocks - lowers to seat as knees and hips are flexing						
Knees - flex while lowering trunk.	Right					
	Left					
Feet - Remain flat on floor until buttocks is in seat	Right					
	Left					
Trunk - "Rights" 2 seconds after buttocks is in seat						
Time - Begins with verbal cue "sit down", ending 2 sec. after in seat						

Position of the observers. Once the child is standing, the examiner should move one foot away, slightly to the front of the subject. The observer is similarly positioned on the opposite side.

Providing Cues to the Child

There are two types of cues given to elicit a response from the child:

Verbal cue. The verbal cue "sit down" initiates the trial. If after 30 seconds, the child is still standing, the cue can be repeated.

Physical prompt. Thirty seconds after the second cue is given, if the child is still standing, the examiner can prompt the child to sit by touching him at the hips from behind, and applying slight pressure to promote flexion at the hips.

Measuring Sit in Chair from Stand Without Table

The examiner and observer collect three types of data. The code to indicate hand positioning consists of numbers corresponding to placement of the hands on the arms of the chair, the edge of the chair, on the lap, or not used. A code of correct (+), incorrect (o), or abnormal tone (a) is used to indicate whether or not the buttocks lowered to the seat, while knees were flexing and the feet remained flat on the floor. The third type of data recorded is the response time.

Assessment Procedure

Step 1. Place the subject in a standing position with feet flat on the floor, a few inches apart, depending on the base needed for the child to stand unsupported. The chair should be about two inches from the back of the knees.

Step 2. Give the verbal cue "sit down" to initiate the trial.

Step 3. Begin the stop watch.

Step 4. Stop the trial when the child is seated for two seconds.

Step 5. Record the behaviors observed.

Step 6. Record the response time.

Specifications for Taking Reliability

Reliability scores are determined by comparing the number of agreements and disagreements between the observer and examiner for each of the behaviors demonstrated by the subject using the following formula:

$$R = \frac{\text{No. of agreements}}{\text{No. of agreements} + \text{No. of disagreements}} \times 100.$$

The response time in each session is calculated by dividing the smaller time into the larger time and then multiplying that number by 100.

Measuring Standing from Floor Without Support

Specification of Behavior

Standing from the floor without support is briefly characterized by the child's flexing one leg to assume a half-kneel position while placing one foot on the floor and then bringing the trunk to an upright position. Another option for attaining this position is flexing both legs and placing both feet on the floor simultaneously (as if in a squatting position), then bringing the trunk forward to the upright position. In both situations, the hands can be placed on the floor close to the body or used to secure balance by not contacting a surface. Measures taken consist of coding the location of the feet on the floor grid and recording the code that corresponds to the position of the hands, knees, feet and trunk.

Space and Materials Required

The area required includes space for the floor grid (36" x 36"), subject, examiner, and observer. It is important that the assessment also be conducted away from furniture or persons that the child might be inclined to rely on for support.

The floor grid used to measure the other areas of standing can also be used here. That is, the three inch squares numbered 1-36, with six in each row.

Preferred items can be used to elicit the desired response from the child. Additional items needed are the Data Sheet #5 (Figure 8), two stop watches, two clip boards, and pencils.

Observational Setting

Observations can occur in a setting where the child can demonstrate independent standing without the furniture being used as a support. This can be in the child's home, in the classroom, or in any setting conducive to the task being assessed.

Conditions of the Assessment

Initial position. The child should be placed on the floor in the center of the designated area, in a long sitting or ring sitting position. The feet should be in approximately the third row of the grid.

Position of the observers. The examiner and observer should be in front of the subject on either side. It is important that both are far enough away so as not to be a potential support for the child.

Providing Cues to the Child

Verbal cue. The examiner initiates the trial by giving the verbal cue "stand up." This can be repeated if after 30 seconds the child is still not attempting to stand.

Stand from Floor - No Support

Name _____ Examiner _____

Date _____ Observer _____

CODE: Mark the Corresponding Number to the Behavior Observed

Behavior Description		Trials					R
		1	2	3	4		
Hands - (1) Places hands in front of trunk (2) Places hands on side (3) Hands not used (only for balance)	Right						
	Left						
Knees - (1) Placed on floor to half-kneel (2) flexed and extended to upright	Right						
	Left						
Trunk - "Rights" trunk within 2 seconds of attaining upright position - observed or not observed.							
Feet - (1) Placed on floor to come to stand (2) Preceded by half-kneel (3) On toes or sides of foot	Right						
	Left						
Time - Begin on verbal cue "stand up" end after 2 seconds of standing.							

Foot Positions

Grid - Mark X where feet are after 2 seconds of standing

X - flat, — - on toes, - on sides of foot

FEET	1					
	1	2	3	4	5	6
	7	8	9	10	11	12
	13	14	15	16	17	18
	19	20	21	22	23	24
	25	26	27	28	29	30
	31	32	33	34	35	36
	2					
	1	2	3	4	5	6
	7	8	9	10	11	12
	13	14	15	16	17	18
	19	20	21	22	23	24
	25	26	27	28	29	30
	31	32	33	34	35	36
	3					
	1	2	3	4	5	6
	7	8	9	10	11	12
	13	14	15	16	17	18
	19	20	21	22	23	24
	25	26	27	28	29	30
	31	32	33	34	35	36
	4					
	1	2	3	4	5	6
	7	8	9	10	11	12
	13	14	15	16	17	18
	19	20	21	22	23	24
	25	26	27	28	29	30
	31	32	33	34	35	36

Figure 8. Data Sheet #5.

Physical prompt. After the second verbal cue plus 30 seconds, if the child has still failed to initiate a response, the examiner can prompt the child from the back by touching him under the arms or lifting the buttocks in a forward motion.

Measuring Stand from Floor Without Support

Three types of data are collected by the examiner and observer. The code corresponding to hand placement includes three options: hands in front of trunk, on the side of the trunk, or not used. The knees can be either placed on the floor to half-kneel, or flexed and extended. The feet options are: placed on the floor, preceded by a half-kneel, or on the toes. All of the options have numbers that correspond to the behavior demonstrated by the child. The trunk is coded either correct (+), incorrect (o), or abnormal tone (a). The time response is recorded also. Coding for the foot grid consists of placing a mark on the grid that corresponds to the position of the feet (whether it is flat, on sides of foot, or on the toes), and the location of the feet on the grid.

Assessment Procedure

Step 1. Place the child on the floor in a ring or a long sitting position.

Step 2. The trial begins when the examiner gives the verbal cue "stand up."

Step 3. Begin the stop watch.

Step 4. The trial ends when the subject has assumed a standing position for 2 seconds.

Step 5. Record location of feet on the floor grid.

Step 6. Record behaviors observed.

Step 7. Record response time.

Specifications for Taking Reliability

Reliability scores are determined by comparing the number of agreements and disagreements between the examiner and the observer for each of the behaviors demonstrated by the subject using the formula:

$$R = \frac{\text{No. of agreements}}{\text{No. of agreements} + \text{No. of disagreements}} \times 100.$$

The reliability scores for the time response in each session are calculated by dividing the smaller response time into the larger response time and then multiplying that number by 100.

Grid reliability. Reliability scores for the grid are calculated according to the following criteria. The grids completed by the observer and examiner were compared for agreements and disagreements. The observers were considered to be in agreement if the following criteria were met: a) X's indicating placement of the child's hand or foot were located in exactly the same square, b) any portion of the X indicating placement of the child's foot recorded by the observer that appeared in the same square as that of the examiner. Observers were considered to be in disagreement if the recorded code for the position shared no common location on the grid.

Measuring Sit to the Floor Without Support

Specification of Behavior

Sitting on the floor from a standing position without using support is characterized by the subject's bending one or both legs to assume, respectively, a half-kneel or squatting position while lowering the

buttocks to the floor. The hands can be placed on the floor to assist in weight shifting, or they can be "left free" to secure balance. The measures taken consist of coding the observed hand, knee, and feet positions assumed by the child.

Space and Materials Required

The required area includes space to accommodate the subject, observer, and examiner. The area must be large enough so as to inhibit the subject's tendency to move toward furniture for assistance in lowering his body to the floor.

Reinforcing items can be used to motivate the child to "sit.". Data sheet #6 (Figure 9), two stop watches, clip-boards, and pencils are additional items needed to complete the assessment.

Observational Setting

The observations can take place in any structured setting conducive to eliciting the sitting behavior from the subject. This can be in the home, classroom, or any school setting.

Conditions of the Assessment

Initial positioning. The child should be placed in an independent standing position away from furniture and persons.

Position of the observers. The examiner should move approximately two feet away from the subject after positioning. Observers should be to the front of the subject and on either side.

Providing Cues to the Child

Verbal cue. The examiner initiates the trial by giving the cue "sit down." A second cue is given if after 30 seconds, the child is still not attempting to sit down.

Sit to Floor Without Support

Student _____ Examiner _____

Date _____ Observer _____

CODE: Correct response (+)
 incorrect response (0)
 abnormal tone (a)

		Trials				
		1	2	3	4	R
Hands - (1) lower to floor in front of trunk (2) lower to floor-side (3) Not Used	Right					
	Left					
Knees - (1) Flex while buttocks is lowering to floor (2) legs remain extended	Right					
	Left					
Feet - (1) remain flat until buttocks reaches floor (2) Leave floor when knees flex	Right					
	Left					
Time - Begins with verbal cue "sit down" and ends after 2 seconds of sitting.	Right					
	Left					

Figure 9. Data Sheet #6.

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Physical prompt. The examiner can prompt the child after the second verbal cue is given and 30 seconds has elapsed without response. The prompt consists of touching one or both hips and applying slight pressure to generate flexion.

Measuring Sit to the Floor Without Support

Two types of data are collected for this area of measurement. The code of behaviors includes a number assigned to the position of the hands: on the floor, on the side, or not used. The knees are coded as either flexed while buttocks are lowering to the floor, or extended. The feet are coded as flat on the floor, or leaving floor when knees flex. The time is also recorded.

Assessment Procedure

Step 1. Place the child in a standing position in the center of the assessment area.

Step 2. Give the cue "sit down."

Step 3. Begin the stop watch.

Step 4. The trial ends when the child's buttocks are on the floor.

Step 5. Record behaviors observed.

Step 6. Record response time.

Specifications for Taking Reliability

Reliability scores are calculated by comparing the number of agreements to disagreements between the observer and the examiner for each of the behaviors demonstrated by the subject using the formula:

$$R = \frac{\text{No. of agreements}}{\text{No. of agreements} + \text{No. of disagreements}} \times 100.$$

The reliability for the time response in each session is calculated by dividing the smaller response time into the larger response time and then multiplying that number by 100.

Results and Discussion

The Results and Discussion from a study implementing these procedures are presented in Volume II: Interobserver Reliability Results for the Procedures, pages M(S)1 to M(S)15.